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NATIONAL POLICY AND ISSUES

CHINA'S SOCIALIST PLANNED ECONOMY REVIEWED, DEFENDED

Beijing JINGJI YANJIU [ECONOMIC RESEARCH] in Chinese No 2, 1981 pp 37-45

[Article by Luo Gengmo [7482 5087 3351], Institute of Economics, Chinese Academy of Social Sciences: [Analysis of the Formation of China's Planned Economy and Its Course of Development"]

[Text] In the capitalist society, the production within each factory is well planned and graduated. However, due to antagonistic contradictions arising from the capitalist system of private ownership, production by division of work in society as a whole is not at all well planned and graduated, but is anarchic.⁽¹⁾ Once society takes possession of the means of production and eliminates the contradiction between socialized production and capitalist monopoly, "well planned voluntary organization will replace" anarchy inside social production.⁽²⁾ There is a consensus in our country that this is true in the case of the socialist economy based on public ownership by the whole people. However, opinions differ as to whether planned economy could develop according to well set plans and ratios in an under-developed socialist economy composed of diversified economic components. Some people even doubt whether our existing socialist economy could claim such superiority. We will examine this question in the light of the 30-year economic history of New China.

1. The Formation and Characteristics of Our Planned Economy Composed of Diversified Economic Components

We all know that after the founding of New China, the first step was to take control of the KMT bureaucratic compradore capitalist industrial and commercial enterprises as well as the foreign industrial and commercial concerns of the imperialist aggressors in China and turn them into an economic system of ownership by the whole people. The land reform which followed wiped out the feudalistic economic exploitation. A nationwide change set in when the capitalist industry and commerce, agriculture and handicraft industry went through the socialist transformation. This is shown in the following table based on relevant statistical data.

Relative Strength of the Components of the Chinese Economy 1949-1957:

Relative Strength of Various Economic Components	1949	1952	1957
	(1950)		
Percentage of Rural Households in Mutual Aid & Co-op Units	10.7%	40.0%	97.5%
Including: Advanced Co-ops	—	0.1%	96.2%
Elementary Co-ops	—	—	1.3%
Mutual Aid Units	10.7%	39.9%	—
Gross Output Value of Handicraft Industry Cooperativized	—	3.5%	95.2%
Co-op Handicraft Industry	—	96.5%	4.8%
Individual Handicraft Industry	—	—	—
Gross Output Value of Capitalist Industry in Socialist Transformation	—	—	—
State-Coop Joint Enterprises	3.1%	11.5%	99.8%
Processing Orders, Marketing Contracting, Requisitions	11.5%	49.6%	0.2%
Private Production & Marketing	85.4%	38.9%	
Ratios of Various Economic Components in Gross Output Value			
State-operated	26.3%	41.5%	53.8%
Joint State-private Operated	1.6%	4.0%	26.3%
Co-op Operated	0.4%	3.2%	19.3%
Private Industry	46.7%	30.7%	0.1%
Individual Handicraft Industry	23.0%	20.6%	0.8%
Ratios of Various Economic Components in Total Retail Sales	(1950)		
State Economy	6.9%	16.2%	37.2%
Supply & Marketing Co-op Economy	4.7%	18.2%	24.9%
State Capitalist & Cooperativized Economy	0.1%	0.4%	31.9%
Private-operated Economy	88.3%	65.2%	6.0%

Now when we re-examine the socialist transformation of agriculture and handicraft industry in those years in the light of our 30-year experience, we find a few controversial points. For instance, the original schedule for its completion in three 5-year periods was suddenly pushed through in 10 years. This deviation of pursuing quick results was spurred by a flash of success of the movement. In the case of the "huge collective" people's commune movement the deviations were even more serious. Although the deviations were corrected at one time, the lack of a thorough ideological summation of the drive and the disruptions brought about by the "communist storm" and "pauperization" drives during the 10 turbulent years under Lin Biao and the "gang of four" proved extremely disastrous. Consequently, the party had to adopt a set of new measures wherever applicable to uproot the pernicious influence of the extreme leftist line of the "gang of four."⁽³⁾

In retrospect, we realize the problems that had occurred at that time. But the cooperativization movement in the First Five-Year Plan period was basically a success. Take the industrial and agricultural gross output value for example. Supposing it was 100 in 1949, it went up to 146.8 in 1952 and 297.9 in 1957. That is to say, the 1957 increase was twice that of 1949 and one and a half times that of 1952. In 1957 the total value of commodities sold at retail in both urban and rural areas was 52.15 billion yuan, up by 60 percent compared with that of 1952. At that time, coupon restrictions and ration allowance were much simpler than they are today. The absolute commanding position won by the socialist economic system of public ownership became the foundation of our socialist planned economy. Let us elaborate on this point a bit more fully.

The role people play in the economy and whether they could produce and exchange according to plans depend not so much on their subjective wishes as on their relationship to the ownership of the means of production (including natural resources). In other words, the whole thing rests on the relationship by which the means of production and labor are joined together. This relationship controls the way people produce, exchange and distribute their products. The economic wishes of man (what he wants to do) reflect these relationships in man's mind. All the economic laws (including property law) are the focal representations of those economic relationships and wishes, the peak of the social superstructure. So the study of social economic relations and their laws in political economy must focus on the ownership of the means of production and, instead of dwelling on this point metaphysically, cover actual production relations (in the strict sense), exchange and distribution relations. The grouping of the components of the economy denotes classifications based on the system of ownership. When we say there are many economic components, we mean a blending of many forms of ownership. This poses a problem in our analysis. If different forms of ownership are blended together, how are we going to treat them in our analysis? Since they are not equal in strength, we must distinguish which is more powerful and which occupies a controlling position, as well as the general social economic trend under its control. This principle was well expounded by Marx who said: "...In every society there is one production which determines the position and impact of all other kinds of production. It is a light which outshines everything else and makes all things change according to their unique characteristics."⁽⁴⁾ This is a universal principle. During the first 3 years of our rehabilitation, the components of our economy fall into five different categories: (1) the socialist economy of ownership by the whole people, (2) the proletarian economy of state capitalism (including joint state-private ownership, orders placed by the state with private enterprises for processing materials or supplying manufactured goods, etc.), (3) the embryonic cooperative economy of small farms and handicraft industry, (4) the privately owned economy of petty peasants and handicraftsmen, and (5) the national capitalist economy.⁽⁵⁾ Each of these economic components is different from the other. The first and the fifth, like the two opposing sides at a tug-of-war, represent the two extremes. As far as this study goes, the enterprises under the socialist economy of ownership by the whole people, in spite of their limited non-hostile contradictions in interests, must divide their work and cooperate closely in a planned and organized way before they can expect to grow continually, triumph over capitalism and earn a maximum amount of wealth (use value) with a minimum amount of labor. Consequently, the first economic component depends on uprooting the cut-throat competition and anarchical state of production under the

capitalist system. The national capitalist economy, different as it is from the bureaucratic compradore capitalism, is still a form of capitalism. Its creed is to chase after profit until they are forced to accept certain restrictive ratios. The state capitalism economy represents the beginning of the socialist transformation. It is a limited capitalism under the control of the proletarian state, already on the side of the socialist economy of ownership by the whole people. The production by the small farms and handicraft industry is a non-socialist production by individuals, a privately owned economy favoring the capitalist trend of spontaneity. However, it is a privately owned economy of the working people depending more or less on the big socialist industrial and commercial enterprises and following the socialist line (especially the poor and lower middle peasants who had received land during the land reform) to fend off the pull of the two extremities. Caught between the first and the fifth components, it will stick to socialism once they form cooperatives with the guidance and assistance of the proletarian state.

The relative strength of the aforesaid five economic components during the rehabilitation period is as follows: The first component (including the second component) which had grown from 28.3 percent to 34.8 percent in the gross national output value was gaining strength due partly to the political strength of the worker-peasant alliance. But it was not as strong as the fifth component, a spontaneous force oriented toward capitalism as the small farm economy of more than 80 percent of the nation's population remained unorganized and productivity was low. So at that time it was impossible to overcome the anarchical conditions of production in China. For instance, the fourth wave of nationwide price fluctuation due to idle capital and speculation (plus inflation at that time) remained unabated until March 1950 (completely resolved in the summer of 1952 during the second drive to readjust industry and commerce). The "five evils" practiced by the capitalists were not uprooted until the "five-anti" campaign. These disturbances are indications that unified planned economy was very difficult to realize at that time.

The socialist planned economy of New China took shape during the drive of "socialization and three transformations" 1953 to 1957. The success scored was due to several factors. The major reason is that all the sectors concerned proceeded with great care to keep the socialist capital constructions in proper ratios. Secondly, the basic completion of the "three transformations" helped absorb the greatest majority of the small farms and handicraft industry into the cooperatives under collective ownership (economically this was guided and assisted by the socialist economy of ownership by the whole people and by industrial products provided by the socialist large industries to trade for agricultural products). The greatest majority of the capitalist industry and commerce were converted to joint state-private ownership. Thus the component consisting of the socialist economy of ownership by the whole people became the leading component of the socialist economy, the "beacon" lighting up the path leading to the elimination of anarchism in commodity production by both the capitalists and petty merchants and absorption of the cooperative economy of agriculture and handicraft industry (also a part of the individual economy) into the orbit of planned economy. These historical facts attest that the unified socialist planned economy does not have to wait until the realization of an exclusive socialist public ownership. It could co-exist with many other economic components, provided the large socialist industry and commerce are already in a dominant controlling position.

The unified planned economy established in New China during the First Five-Year Plan period on a foundation of multiple economic components is the result of struggle between the socialist and capitalist lines based on the strength of the interests and demands of the several economic components. This kind of socialist planned economy represents on the one hand a unified system extending without exception to every sector of the national economy. On the other, it is not a true planned economy because it contains varying degrees of impurity (spontaneous forces), which breeds instability. This could not be eliminated until we reach the stage of exclusive socialist ownership by the whole people. These are the unique characteristics of our socialist planned economy of today. If we do not have a dialectical understanding of both aspects, we might get confused by certain complications. For instance, in the past 30 years when the planned economy of New China was in force, we ran into many setbacks and deviations. We must sum up the experience and draw lessons from it. The experience and practice as a whole tell us that the setbacks experienced during the progress of the implementation of the socialist planned economy (even though some are very serious and some are tied to their historical background) are only temporary and could be rectified by the system itself. It does not imply that our national economy, like that of the capitalist countries, is not amenable to unified planning at all.

II. A Review of 30 Years of Planned Economy in New China

When we say that the capitalist economy is so blind and anarchic that it is not amenable to unified planning by both the capitalists and the capitalist state on behalf of society, we do not mean that the capitalists and the capitalist state are unable to predict the social (market) supply and demand or intervene in their national economy. We must not view the capitalist economy so superficially. The fact that we say the capitalist economy is not amenable to unified planning by the capitalist state on behalf of society is that the contradictions between the capitalist system of ownership and socialized production force the capitalists or monopolist blocks to compete for survival and make money at the expense of others instead of agreeing to take coordinated steps. Even if they were able to predict precisely the market changes, they would not be able to tell the sellers and the buyers what to do or how to coordinate their efforts. They could only aggravate the tension and sharpen the competition until a crisis sets in to force the social supply and demand back to a temporary equilibrium. We say once society takes possession of the means of production (even when the socialist ownership by the whole people occupies only an overriding position over all other economic components), it will be able to lead the social production as a whole to develop in a planned and well graduated way because it has done away with the basic contradictions between socialized production and the capitalist system of ownership. This, however, does not mean that the proletarian state could automatically go straight ahead to develop the national economy according to established plans and ratios. We must remember there will still be setbacks. These setbacks, or distortion of ratios, unlike the state of anarchy and crisis in the capitalist economy, are amenable to correction under the socialist system, and allow the law of planned and graduated development of the national economy to work even better. Stalin, in his analysis of this problem, said: "We must not lump together our annual plan and five-year plan with the law of planned and graduated development of the national economy. This law of planned and graduated development of the national

economy founded on public ownership of the means of production....makes it possible for our planning agencies to plan social production correctly. But possibilities and realities are not the same. They are two different matters. To turn a possibility into a reality, we must study and master this economic law, acquire the skill to use it and work out plans which reflect accurately its requirements. We could not say our annual and five-year plans do reflect accurately the requirements of this economic law."⁽⁶⁾ Stalin made the following two points very clear.

(1) After the capitalist system of private ownership is replaced by the socialist public ownership, although there is a possibility for the proletarian state to develop its national economy according to established plans and ratios, it must make its plans meet the requirements of the law of economic development according to definite plans and ratios in order to turn the possibility into reality. It is not easy to do so, nor would continued recitation of the law do us any good. To master and acquire the skill to use the law, we must understand well the basis and requirements of this law in the light of Chinese history and the current situation. Moreover, we must also know precisely the true content of various ratios implied in Stalin's idea of "according to plans and ratios." This means that we have to master such major ratio relationships as the ratio between supply and demand and that between consumption and accumulation, as well as a more complete knowledge of other ratio relationships (including even such matters as the quotas of material consumption, labor force and funds). If we do not pay close attention in our planning to those economic ratios and data and brand them as trivial matters, we are likely to come up with impracticable plans and turn "the development of the national economy according to plans and ratios" into idle talk.

(2) The annual and five-year plans of the Soviet Union had actually fallen short in certain areas in measuring up to the requirements of the law of planned development of the national economy. This is also true of the long-term and short-term plans we have worked out since 1953. Does this mean, as some people have suggested, that we would not be able to have a unified planned economy, since we have not yet achieved a higher degree of socialized production? We have to answer this question in the context and nature of those errors which we have run into since 1953.

We all know that when we began in 1953-1957 to implement the First Five-Year Plan, we were inexperienced but worked hard to learn from the experience of the Soviet Union in its five-year plans, and strived to keep our accounts and maintain a comprehensive balance of manpower, finance and material resources (including foreign trade). As a result, the implementation proceeded so steadily that it was well fulfilled or overfulfilled. However, due to shortcomings in planning and lack of adequate knowledge of the ratio relationships of the national economy, we had to readjust the plan now and then during its progress. These setbacks in a planned economy are unavoidable both at the early stage of the plan and in the future. Under socialism, even though the interests of all the sectors of society have become basically identical and we could proceed according to plans and proper ratios with production, distribution and exchange after the elimination of the adversary relationships under the capitalist system of ownership, the realization of this economic law, like any other law of the socialist economy, depends on how well it is understood by people through the process of "practice--understanding--more practice--more understanding." Consequently, all national economic plans are unlikely to reflect accurately the requirements of this objective economic law and

will require frequent readjustments and corrections. This is a matter of perception, a normal phenomenon of the actual realization of the law of developing the socialist national economy according to accepted plans and ratios. Nobody has claimed or still claims that our socialist economy would not develop according to accepted plans and ratios simply because the economic plan at that time had sustained these setbacks and gone through readjustments.

Moreover, the fact that our First Five-Year Plan had to be readjusted and ran into certain setbacks as it was implemented is not due entirely to general perceptual reasons. It is partly due to the fact that as a semi-colonial and semi-feudalist society, China did not have the cultural and technological background of well developed capitalist large-scale production. For instance, it did not have systematic historical statistical data on the various sectors of the national economy, nor did it have enough capitalist experts to serve the various trades. All these naturally affect the validity of the national economic planning (not only the formulation of the First Five-Year Plan). This, however, does not mean that planned economy is unfit for New China. Moreover, these unfavorable factors will be overcome step by step under the socialist system. This is the way to gain an overall view of the problem.

Unlike the First Five-Year Plan period, the Second Five-Year Plan period was beset by serious dislocations of the ratios and poor performance in implementing the plan. What are the reasons for this and what does this mean? Let me describe the grain and steel productions projects which affect the entire national economy as examples to explain and resolve the problem.

The volume of grain production is the most important target of our national economic plan. In his report on the proposed Second Five-Year Plan to the 8th CCP Congress in 1956, Comrade Zhou Enlai said the volume of grain production contained in the Second Five-Year Plan was set to increase to about 500 billion jin in 1962. That was an ambitious project. During and following the wheat harvest of 1958, bulletins of happy tidings of a best bumper harvest since the cooperativization began to fan out from all localities, especially those model areas where "grain satellites" had been ascending continually from 1000 jin to several thousand jin per mu. Some even believed that the total volume of grain production for the whole nation in 1958 could reach as much as 1000 billion jin. The figure published by the State Statistical Bureau in 1959 was 750 billion jin (double that of 1957). Consequently, many comrades were quite concerned about the rapid increase of grain production. Believing that if the grain were not exported we would not be able to build storages fast enough to meet the need, they proposed to cut back the grain acreage to make room for economic crops and afforestation. At that time I myself was fascinated by this beautiful picture in the country's future, which I realize now represents nothing but wishful thinking. But that was what we actually planned to do at that time. The spread of mess halls in the rural communes and the slogan "free food" were the steps taken to put the idea into practice. In reality, the increase registered in 1958, as verified later, was only a few percentage points over that of 1957. That short-lived food consumption spree was backed up by the grain reserves of the preceding 2 or 3 years. The visitation of famine in the villages in the winter of 1959, especially 1960-1961, which brought about rapid declines of grain production and dislocation of ratios, finally dashed the dream to pieces. The national economy ran into so much difficulty that even the RMB,

which had been stable for nearly 10 years, began to depreciate. Now we see clearly what was responsible for the serious dislocation of the ratios of the national economy.

First of all, the socialist transformation of the small farm economy not engaged in socialized production went a bit too far. This is especially true of the "big collective" rural people's commune movement which stirred up the "communization storm" and the "blind command storm" which actually violated the law of the coordination of production relations and productivity, dampened the productive enthusiasm of the peasant masses and clipped a part of the rural productive force built up in the preceding years. As a result, the Second Five-Year Plan ended in 3 years of rapid decline of production instead of a great leap forward in agriculture.

Secondly, the extension of the anti-rightism drive of 1957 and the "anti-rightist struggle" of 1959 made people both within and outside the CCP afraid to tell the truth. When they reported only the good instead of bad news, the authority at the top also began to show interest in only one side of the story, an encouragement to "boasting and exaggeration." All statistical data and investigation reports have lost their credibility as they covered up and white-washed food shortages in the villages.

The third cause is natural calamity in 3 consecutive years. At that time people argued whether the first or the third cause was the principal reason for the setback. If we were to draw a conclusion now, we would say "human factors" played a more decisive role than "forces of nature." This is the only way to evaluate history so as to sum up a lesson from the experience.

Being a large country dominated by a farm economy of small-scale production, our light and textile industry as well as the livelihood of the people are affected each year by natural calamities of different magnitudes. Consequently, our agricultural plan should be somewhat conservative and yet aggressive under the premise of conservatism. The projection and statistical data of actual annual grain production must be verified at all levels, and we must not be duped again by "typical excessive estimates" of the past. The impact of natural forces must be stated truthfully in the annual performance summations. The unfathomable effect of the natural forces should not be turned into an "analysis moderator" of plan performance. For instance, one could blame the forces of nature for project failures no matter what the real cause is, or leave them out when they actually contributed to project successes. To take advantage of such "maneuverability" is to ruin the socialist economic planning and the credibility and trustworthiness of control and supervision by means of statistics.

Here I wish to go over an article I wrote in September 1958 to criticize Mr Ma Yinchu [7456 1377 0443].⁽⁷⁾ The main theme of that article is to refute Mr Ma's new theory of population. At that time I believed "the practice of birth control to protect the health of women and children and to cut back household chores to help children receive better family education is necessary now and even after communism is realized." But I thought the birth control policy and measures advocated by Mr Ma in 1957 and 1958 to cope with the contradiction that our country has "too many people, not enough land and not enough capital" represented a

"modified form of Neo-Malthusianism." After many years of practice and examination, Mr Ma's views are now proven correct. Instead of vouching for "Neo-Malthusianism," they spoke for Mr Ma as a valiant defender of truth. Looking back now, my criticism of Mr Ma is absolutely wrong. Being a student of economics, I ought to draw a lesson from what had happened. I was already 50 years old when I wrote that article. But why did I write the article, which could not pass the test of reality? Apart from my limited level of experience and education, I believed the socialist transformation of the small-scale farming was quite simple and that a more populous commune would be more productive than a less populous one. Secondly, although the claim that the grain production in 1958 after the establishment of the communes might go over the 1000 billion jin mark was an over-inflated "satellite," a "drop" to 600-700 billion jin would still be something substantial enough to assure continued growth even if the rate of growth slowed down in the next 4 years. Consequently, I felt sure that Mr Ma's theory of population did not keep pace with the actual conditions.

Now let us take a look at the steel production plan during the Second Five-Year Plan period. Our steel production in the First Five-Year Plan period rose from 1.35 million tons in 1952 to 5.35 million tons in 1957, overfulfilling the plan target. It was pretty tight but we did what was necessary and possible. In his report on the Second Five-Year Plan to the 8th CCP Congress in 1956, Comrade Zhou Enlai proposed that the projected steel production should be 10.5-12 million tons by the year 1962. This increase is 1-1.2 times the projected production of 5.5 million tons for 1957. These projections were well founded, because the industrial construction achieved during the First Five-Year Plan provided us with a rudimentary base for modern heavy industry, much better than what we had during the rehabilitation period. In the latter part of 1958 when all the localities began launching "grain satellites" and "steel production satellites" representing groups of small indigenous factories, the projected steel production for 1962 was replaced by a new project which pushed the total up to 18 million tons. The actual volume produced was about 8 million tons in 1958, 13 million tons in 1959 and 18 million tons in 1960. A large part of the steel produced in these 3 years came from the indigenous factories and small blast furnaces, and had to be smelted again in "big foreign furnaces." The cost was so high and quality so poor that this unreal "peak" did not last very long. Consequently, the production was forced to cut back, a severe blow to the machine making industry and many capital construction projects which use steel as raw material. What are the reasons for and implications of such severe dislocation of the ratios of the national economy and the setbacks during the Second Five-Year Plan period? The following are the basic reasons.

In the first place, the heavy industry build during the First Five-Year Plan period was so overestimated that we went too far to achieve quick results. Haste makes waste.

In the second place, people were so dazzled by the "grain satellites" of small-scale production that they began to lose confidence in modern large-scale industry. They thought that the small indigenous factories and small blast furnaces were "very promising" and capable of playing such a vital supporting role in boosting steel production that they might stand alongside the Anshan Steel to promote "both indigenous and modern factories" and a "union of large, medium and small industries." This is unscientific foolhardiness. The program to promote both

indigenous and modern factories and the union of large, medium and small industries laid down by the general line of our socialist construction is a long-term projection. Our country has a huge population and a tremendous labor force but lacks money and technology. Consequently, small-scale production of unique native products and traditional handicraft articles, household sideline products of both rural and urban residents, products turned out by various lines of services (including shopkeepers and hawkers) as well as medium and small scale processing industries which require concentrated labor are worth promoting as we strive to develop our socialist construction. Yet after the socialist transformation of agriculture and handicraft industry was basically completed in 1957, not much has been done to promote these medium and small economies (let alone the drive to "clip their wings" during the 10 years of turmoil). On the other hand, "promotion of both small and indigenous factories" gained momentum in the smelting industry, which needs modern technology rather than the "human sea tactics." This means, as we used to say, to bring forward our weaknesses and put down our strong points instead of bringing forward our strong points and putting down our weaknesses. Such being the case, no wonder we have wasted so much manpower and material resources.

In the third place, the fact that the Soviet Union had perfidiously torn up agreements and contracts, pulled back their specialists and stopped providing equipment and technology constituted an outside factor which contributed to the setbacks sustained by our smelting industry during the Second Five-Year Plan period.

The aforesaid account of the failure to achieve full realization of the grain and steel production projects resulting in serious dislocation of the ratios of the national economy is due neither to the complications usually associated with the execution of the plan nor to general perceptual errors, but tied to the following unusual situations.

First, although the whole country had had very little experience (especially unfavorable experience) in socialist construction, we were in a hurry to build up a large-scale socialist industry. So the success in completing the socialist transformation and overfulfilling the First Five-Year Plan gave rise to varying degrees of complacency and an urge to pursue quick results. Arrogant and impatient, we thought everything would charge ahead in full steam at the crack of the whip. Moreover, the anti-rightism campaign and the anti-rightists struggles gave many people the impression that "left" is better than right. So people prefer to act recklessly than being labelled rightists.

Second, emerging from a semi-colonial and semi-feudalist society, the urban and rural residents of New China, low in educational and technical levels, are possessed with petty peasant mentality, always looking up to good leadership and chieftains to take charge. Consequently, once the line and method of leadership went wrong, the situation would deteriorate and finally get out of control.

In summary, the fact that the plan fared so poorly during the Second Five-Year Plan period that the great leap forward became a great leap backward and the ratios of the national economy were severely disturbed are attributable mainly to complacency and foolhardiness. Of course the working class and the worker masses have

not been assertive enough as the new master of the socialist society. Be that as it may, these, after all, are only transitory and localized problems which we "could resolve as we learn." They are by no means inherent roadblocks in our under-developed socialist economy which would rule out planned economy altogether. For instance, the program of "readjustment, consolidation, replenishment and improvement" of 1963-1965 proved effective enough to overcome the difficulties of the preceding 3 years and put the national economy back on the right track. At that time, nobody, whether within the party or outside, had ever questioned the validity of the basic relationships described above. These are fair comments.

Finally, let us see why people began to question the matter in the past couple of years. I think this has something to do with the following facts. The conspiratory scheme of Lin Biao and the "gang of four" to push through the extreme leftist line during the 10 turbulent years was responsible for leading our national economy to the brink of bankruptcy. Under the banner of "proletarian politics taking command," they practiced feudalistic fascist dictatorship and used the "pursuit of productivism" as an economic weapon to crack down on promotions of production, alleging that "wealth breeds revisionism." They misrepresented Marx's criticism of the "Goethe Program" of LaSalle and attacked the principle of material incentive and distribution according to work. Yet they defended the debauchery and squandering of the privileged few. They closed the country to systematic introduction of advanced technology from abroad based on principles of national autonomy and reciprocal benefit, and kept our productivity and technology far below the advanced international level. While opposing rational management and unified planning for our modern socialist enterprises, they turned the national economy topsy-turvy by their undisciplined and obstructive factional activities. Yet their mouthpiece papers and periodicals kept bragging about "thriving prosperity" and "leisurely comfort." We can see that the deterioration and anarchical state of our national economy during those 10 turbulent years are but temporary and localized setbacks sustained by the socialist political economy at the heel of a historical coincidence. This historical coincidence which permitted Lin Biao and the "gang of four" to run amuck for 10 years is embedded in the fact that New China, hitherto a semi-colonial and semi-feudalistic society, still bears the imprint of the feudalistic clan system, theocratic dogmas and trust in "benevolent emperors." Such being the historical background, the situation would become even more precarious once the vanguard of the proletariat--the democratic centralism within the Communist Party--faltered and the political line deviated, especially mistakes of the leaders (such as unwarranted complacency, arrogance, impatience, neglect of criticism and self-criticism and rejection of dissenting views), because these are easily exploited by unscrupulous people, and dampen the active class forces with which the party members and the people struggle against them. Unfortunately, these "ifs" had become realities in one form or another during those 10 years. But the Chinese people and the Chinese Communist Party have finally triumphed over the counter-revolutionary bloc of the "gang of four." As the pernicious influence of Lin Biao and the "gang of four" is being uprooted, we have revived the collective leadership and best traditions of the party and established and strengthened the socialist democracy and its legal system. Even though there will still be obstacles and roadblocks in the new long march, they will be wiped out by the creator of history--the people. I am not going to dwell on this any more. Another question I propose to explore is whether we can have unified planned economy or only fragmented

planned economy, since our country has just emerged from a semi-colonial and semi-feudalist society; the existing socialist economy composed of various economic components is still underdeveloped and influenced by the backward ideology of the old society; and we have failed to do well the planned economy in 15 (especially the 10 turbulent years) out of the last 30 years. I think the question should be answered in the light of the total experience of the past 30 years on the one hand and the current situation on the other. Although our existing underdeveloped socialist economy makes unified planning difficult and complications of one kind or another are bound to crop up (we must do our best to eliminate the complications, especially serious ones), we will no doubt be able to develop our national economy according to set plans and ratios, because the socialist economic system of ownership by the whole has become so strong that its large industries can provide adequate industrial products to trade for the agricultural and handicraft products. We have also summed up and acquired enough favorable as well as unfavorable experience to overcome the pitfalls in planning and other related activities. For instance, the readjustments introduced in a 3-year period from 1963 to 1965 proved effective enough to rectify the dislocation of ratios sustained during the Second Five-Year Plan period. The currency ideological, political and organizational lines formulated and implemented since the Third Plenary Session of the 11th CCP Central Committee, the shift of work priority of the whole party to the four modernizations, and the latest program of "readjustment, reform, reorganization and improvement" adopted and enforced for a year or so have already revitalized the economy as planned. These are testimonies of the validity of our point of view. To guard against possible obstructions as we embark on another long march, we must renew our confidence and double our efforts in both work and struggle. The socialist system of public ownership is a planned economy, a natural product of history.

When we launch the four modernizations, there are likely to be difficulties and new problems awaiting solution. But they differ diametrically from the hardships and crises confronting the West today, because the latter, brought about by all kinds of antagonist contradictions in the capitalist system, could not be satisfactorily resolved unless that system is changed (abolished). We are still in the initial stage of our socialist construction, but the difficulties we run into are temporary and could be overcome as the socialist system matures and as we learn from our past experience. These two systems are entirely different. We must keep this distinction in mind.

FOOTNOTES

- (1) An analysis of this problem based on the principles expounded by Marx and Engels and the reality of the capitalist economy as of today is in my article "Planned Economy and Market Predictions in the Capitalist Countries," in WUZI GUANLI [MATERIALS MANAGEMENT] No 1, 1980.
- (2) Engels: "Anti-Duhring," in "Selected Works of Marx and Engels," Vol 3, The People's Press 1977 Edition, p 323.
- (3) My comments on this particular area are in the sketches in XINGUANGCHIA [NEW OBSERVATIONS] 1980, Vol 2.

- (4) Marx: "Outline of Critical Study of Political Economy" Vol 1, "Introduction," The People's Press 1973 Edition p 32.
- (5) The Tibetan feudalist serf-system economy awaiting transformation is not included.
- (6) Stalin: "Problems of Soviet Socialist Economy," The People's Press 1961 Edition pp 5-6.
- (7) See JINGJI YANJIU [ECONOMIC RESEARCH] 1958, No 10.

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CBO: 4006

NATIONAL POLICY AND ISSUES

FACTORS IN READJUSTING ECONOMY EXAMINED

Beijing CAIZHENG [FINANCE] in Chinese No 2, Feb 81 pp 12-13

[Article by Xu Yi (6079 3015): "Some Differing Views of the Readjustment of the Economy"]

[Text] Most recently, the Party Central Committee and the State Council have declared in no uncertain terms their decision to push for economic readjustment and include every kind of work in the readjustment. The importance of this weighty decision is not yet well understood by all the comrades. Some comrades who want to go all out simply do not want to stop. Influenced for so long by the errant "leftism," most people have an illusion that the more the capital construction projects and the higher the speed of production the faster will the national economy grow, and that the problem now is only a matter of money. These views are to be examined in this article.

Some people who believe we have a large inventory of steel products and mechanical and electrical machine equipment, a sizable force of idle construction workers and a machine industry operating way under capacity allege that we have enough material resources and manpower to handle large-scale capital constructions, but we do not have the money, not enough liquid fund. This, however, does not represent the overall picture.

First, why do we have such a growing stockpile of steel products? The steel products in stock for the current year amounts to 20 million tons. Take the country as a whole, the overstock consists mostly of long-line products. On the other hand, short-line products, such as small section steel, thread steel, steel rods, welded pipes and metal sheets are still short in supply. These overstocked steel products are neither absolutely vital to capital construction nor fit for constructing residential buildings. Therefore we must not assume that capital construction can get off the ground again the moment we have plenty of steel products. Although the overstock was worth several hundred million yuan by the end of June 1980, very few items are good for capital construction. Those items fit for capital construction are supposed to be abandoned. They include metallurgical and chemical industry equipment; equipment imported for the "10 Daqing"; equipment found unfit after importation; expensive but inferior general purpose equipment; planters and pulverizers manufactured for mechanization of agriculture; mechanical and electrical instruments and meters which ought to be eliminated; electrical appliances and parts of machines already eliminated; and so on. In reality, very few items are fit for capital construction.

Second, the scale of the capital construction has become bigger than ever before, but why are the construction corps still idle? The idle corps are the construction units for the metallurgical industry and the PLA railroad engineering corps. They are idle because their division of work is so minute that a unit doing stone work in southern Xinjiang does not know how to do earthwork. No versatile construction unit has ever been idle.

Third, why are some machine making plants idle while the scale of capital construction has expanded? Some chose to attribute this to the discontinuation of the capital construction projects. I do not think that is the case. The machine making industry is losing business because everybody is so preoccupied with projects which are "big and comprehensive" or "small yet comprehensive" that imported equipments have become very popular, even though some of these imports, such as the continuous mining machine, can be manufactured in our country. Many of our enterprises still use old energy-inefficient equipment which should be replaced or overhauled. They should have been the major customers of the machine making industry. However, since the capital constructions take precedence over replacements and overhauls, those customers are in no position to place any orders.

These "three sources of surplus" must be understood very clearly. It is not true that we could push for capital construction as soon as we have the money. Some people tend to regard bank deposits as ready cash, and do not realize that the deposits are funds earmarked for the purchase of material supplies not yet available. These funds must not be loaned to finance capital constructions.

The next point is that some people claim that when we hike consumption and depress accumulation, we lose speed. Their concern is completely uncalled for. The decision of the Third Plenary Session of the 11th CCP Central Committee to readjust the national economy by hiking consumption and reducing accumulation is correct. The expectation of a better standard of living which the people have cherished all these years was redeemed one step after another.

Is it necessary to cut back the accumulation? There is no doubt the accumulation rate must come down. If a higher rate of consumption would arrest the capital constructions and slow down the speed, why didn't we achieve greater speed when the accumulation rate was high in the past? After all, why do we want capital constructions and high speed? The question should be examined in the light of the law of social reproduction, the basic law of the socialist economy and the objective of production.

Finally, some people who believe the question is only a matter of funds are in favor of using financial deficits to cover budgetary overruns, raising funds through bank loans and borrowing from foreign countries to shore up our national resources.

In the first place, can financial deficits really compensate budgetary overruns? Their view in reality alleges that deficits are harmless. They also argue that since the capitalist countries may run into deficits; why can't we? We believe financial deficits, the ultimate outcome of the contradictions in the capitalist system itself, alleviate as well as aggravate a crisis. They are a vehicle of distribution which works for the monopolist capitalists but exploits the working

working people. The capitalist countries may have them, but we can't. The capitalist countries resort to deficit financing to deal with depressions due to declining volume of consumption and inadequate private investments. They are following the Keynesian principle of deficit financing to increase government investments so as to stimulate consumer's demand. As for us, our social demand far exceeds what social production could supply. If we practice deficit financing, we will aggravate the shortage of the means of production and consumer goods, disrupt our plans and hamper stability and solidarity. Moreover, financial deficits in the capitalist countries lead to inflation and exploitation of the working people, but agree with the law of the capitalist economy. It is incompatible with our socialist system and the socialist objective of production.

There are still other comrades who argue that the government bonds we issued during the First Five-Year Plan period are actually deficits which we call bonds instead of deficits. So they claim that financial deficits are not necessarily harmful. These allegations are worth studying. The government bonds of the capitalist countries which differ diametrically from our government bonds are negotiable and therefore a vehicle for the capitalists to make money. The government bonds we issued are to adjust the ratio between capital accumulation and consumption. Judged by the financial distribution of that year, the revenue and expenditure were balanced and the bonds did not disrupt the state plans nor upset the comprehensive equilibrium of the national economy.

It is clear that deficit financing, whether based on Keynesian theory or Feilite-man theory, will not work in our country. It cannot resolve the crisis of capitalism, much less the economic problems of our socialist state. Only Marxism could save China. As for incidental deficits between two fiscal years, they are unavoidable but not at all threatening. They are not the same as deficit financing.

Secondly, can bank credit be used to meet shortage of funds? This idea, an import from the capitalist countries, has been rather popular these days. We know our banks are different than the monopolist banks of the capitalists. Our banks do not handle industrial capital as loans and do not accept private investment in the bank. Apart from the funds owned by the enterprises, the growth of bank deposits is governed by specific rules, held within a specific limit and for specific purposes. It cannot be increased at will or transferred at will for investment in capital constructions. Our bank credit is tied to the circulation of commodities and turnover of funds. It has nothing to do with distribution.

The volume of bank deposits has been growing rapidly in the last couple of years. This is abnormal, because a considerable part of the deposits are conversions of financial deficits. With the prevailing rate financial deficits, the use of bank loans for capital constructions is as bad as incurring financial deficits, adding fuel to the flame. It would seriously upset the balance between the scale of construction and the national resources. To issue new currency to finance the capital construction, like financial deficits, is not different than drinking poison to quench thirst. It is something not to be fooled with.

Thirdly, can we use foreign debts to shore up our national resources? To raise some favorable foreign loans and introduce useful technology are acceptable if we uphold the principle of self-reliance. Unlike financial deficits, foreign loans when used properly are beneficial. However, foreign debts, like financial deficits,

must be paid back. In the final analysis, they are subject to our ability to repay the debts, still a question of our national resources. If we cannot repay the debts on time, we will be the control. The prospect of being led like an ox by the halter is serious enough to require careful consideration. Moreover, foreign loans are not determined by our subjective wishes. We must consider our domestic financial resources to match them. So we must be clear-headed in dealing with the problem of raising foreign loans.

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CSO: 4006

ECONOMIC PLANNING

JAPANESE OBSERVATION OF CHINA'S QUALITY CONTROL

Tokyo NITCHU KEIZAI KYOKAI KAIHO [BULLETIN OF THE JAPAN-CHINA ASSOCIATION ON ECONOMY AND TRADE] in Japanese No 1, Jan 1981 pp 30-34

[Article by Motomu Baba, Chief, Personnel Department, Komatsu Co, Ltd: "Quality Control in China: A Year of Changes"]

[Text] Preface

Having participated both last year and the previous year in Japanese quality control delegations sent to China by the Japan-China Economic Association on the occasion of China's Quality Month, I would like to give my impressions of China's quality control while retracing a one year of changes. The previous year's delegation's (headed by Professor Yoshio Kondo from Kyoto University) itinerary was Beijing, Nanjing in Jiangsu provinces, Hangzhou in Zhejiang province. Last year's delegation (headed by Kohei Suzue, chairman of the Union of Japanese Scientists and Engineers, Inc) visited Beijing, Xian in Shaanxi province, Chengdu in Sichuan province, and Shanghai.

China's Third Quality Month

Every September is China's Quality Month. It is said that the reason September was chosen was "in order to summarize the past year's QC results in time to celebrate the Anniversary of the Founding of the People's Republic of China in October." The first Quality Month was September 1978. At that time a basic QC policy of "Three do's and four don'ts" was spelled out by the Central Committee. The "four don't's" are: 1. Don't use raw material of inferior quality; 2. Don't put inferior quality parts into a product; 3. Don't ship a product of inferior quality; and 4. Don't count products of inferior quality when figuring total output. The "three do's" are: 1. Take the responsibility of repairing consigned products; 2. Take the responsibility of replenishing repair parts; 3. Take the responsibility of compensating damage caused to users. This can truly be called an epoch-making policy, given the situation in which the majority of China's plants, driven to achieve production goals under a system of planned production and planned distribution, had built up a mountain of inferior goods, and in which there was a complete breakdown between product users and the plants, and almost no market information feedback.

The State Economic Commission and the China Quality Control Association seem to have the main responsibility of administering the Quality Month execution plan.

Last year was the third Quality Month, and the completeness of the details of execution and improvement of the essentials of administration were noticeable. Slogans on colorful monthly posters put up in each plant, such as, "Use superior quality products to enhance the people's lives," and "superior quality products will help accumulate wealth for the four modernizations," indicated quite well the present situation of actively trying to improve product quality in its goal of coming up to the national standard product level.

The televised national conference on the Third Quality Month was held in the Great Hall of the People last year, the same as the previous year. At the meeting, Yuan Baohua, vice minister of the State Economic Commission, gave a speech. Just as in the previous year, he emphasized the fact that quality control is increasingly necessary for China's modernization, and he gave the general idea that industry statistics have been prepared by quoting concrete figures to show the results of productivity and improved quality in industrial enterprises in the first half of 1980. For example, out of 68 items from 12 groups of enterprises emphasizing quality, 53 items, equivalent to about 87 percent of the quality index, were up compared to the same period the previous year; and 6 items maintained the same average level as the previous year. Likewise, 1955 out of 8167 kinds of important products from 27 provinces, cities and autonomous regions obtained improved quality results; and 293 were given gold and silver awards in accordance with "regulations for giving awards for superior products." (last year 207 received awards). The majority of products receiving awards the previous year were textiles, craftwork, special brands of liquor, and light industry products; and regionally, the Shanghai district received the greatest number. But last year industries receiving awards increased nationwide and machinery, electrical and chemical industrial products increased. The Kunming Construction Equipment Plant, the Changzhou Diesel Engine Plant, and Jet Fuel from the Lanchow Oil Refinery were selected. In addition, all-purpose lathes, chemical fertilizers, large diesel engines, etc, were also selected. Shandong Province's Tsingjao beer received a gold medal. There is talk that Tsingjao beer is rather hard to find even in the hotels in Peking.

A recent shift can be inferred from the explanation of Yue Zhijian, vice minister of the economic commission on the present situation of China's QC. That is, "The Beijing Internal Combustion Engine Factory and Qinghe Textile Mill were set up as model QC factories; the number of model factories increased to 700 last year and 1,440 this year. Nationwide the number of QC teams is about 32,000 with more than 320,000 people participating. What makes this year different is that many QC presentations were held in the provinces, cities and autonomous regions throughout the country. One hundred twenty-nine selected groups participated in a representative presentation in Beijing and 70 received awards for excellence." His closing remarks, "We will promote appropriate QC measures in each of China's industrial enterprises. To do so, redtapism must be rejected."

The Status of "Rejecting Redtapism"

Two years ago I visited various factories in Beijing, Nanjing, Hangzhou and Shanghai. Each factory receives directives from the Central Committee, and the general pattern in which they are carried out is: 1. proper organization inside the plant; 2. study of QC and stepped-instruction; and 3. establishment of

model work sites and initiation of QC team activity. Last year I visited plants in Beijing, Xian, Chengdu and Shanghai, and had round table discussions. There was a noticeable wide variation in the degree of QC penetration and operation in each plant. Questions to the Japanese side at the time of my visit to the factories and the round table discussions were printed and distributed in advance. This was a characteristic not seen before. Since some of the present situation and issues of China's QC can be understood from the content of the questions, they are presented below.

Beijing Chemical Industry Experimental Plant. 1. What kind of problems were there on your inspection of this plant? 2. What is the structure of Japanese QC activity and what are the methods for maintaining QC activity for a long time? 3. In Japan's chemical plants, how are control charts, histograms and process capability indices used? What about the application of complete QC systems? 4. What kind of control methods are used in Japan besides QC? What is the relationship between them and QC? 5. Please tell us about new QC techniques.

Xian Municipal Economic Committee Discussions. 1. What is the position of a quality guaranteed system in QC? 2. How were problems overcome at the time Japanese QC was introduced? 3. What do you think about quality of work and progress made in standardization? 4. What are some new QC techniques? 5. What about QC in Japan's textile industry? 6. What about methods for worker participation in QC activities and incentive policies? 7. What about top management's policy establishment and development methods?

Sichuan Chemical Industrial Plant. 1. What are the special characteristics of QC in Japan's chemical plants, and the progress of QC team activities there? 2. What about methods of applying process capability indices in Japan's chemical plants? 3. How are QC, IE and VE combined in Japan? 4. How are the problems of quality, energy shortage and safety combined in QC?

Chengdu Rolling Stock Plant (Repair of railroad cars) 1. How is QC furthered in single product, small production or repair shop plants? 2. What about the application of statistical methods in the above plants and in plants where most of the work is handwork? 3. What is the way to promote a quality guaranteed system? 4. How are work standards determined? How are standards set for management and technical sections? 5. What are future trends for Japan's QC? 6. What are your impressions and opinions after having visited our factories?

The above are the main questions. I felt that the plants where questions had been printed in advance were somewhat different in QC level. Examples of the questions in the previous year are: 1. How does QC differ from TQC? Who is responsible for TQC? What kind of TQC has the Japanese Government dictated for industrial enterprises? 2. What is the relationship between QC and inspection, between quality and cost? 3. How is QC furthered in plants with a large variety but small production where control charts and process capability index are not used? 4. What are methods of coordinating between sections? 5. How is QC furthered in such industries as machine, electrical-electronic, steel, chemical and textile industries? 6. What is the difference between QC in Japan and QC in the U.S.? 7. How is QC education promoted in an enterprise? These questions came at the initial introduction stage. Compared to these questions, it can

be seen that the content of the questions last year was the result of understanding from study and practical experience. Quite frankly, I received the impression that these questions were questions to deliberately show their own knowledge. No matter what plant, trees and plants inside the premises and the orderly arrangement of everything both inside and outside the building were far more consistently seen.

One concern is the feeling I got of an insensibility in terms of safety and environmental hygiene found here and there. For example, drive shafts in machinery were left exposed; dust offensive smells and noise were left alone. It is good that air conditioning is used in precision manufacturing and slippers are worn, but there remains the risk of dust flying around with the windows left open. So there are many points needing further improvement.

Superfluous workers are an inevitable problem because of the present guaranteed employment. This problem must be dealt with in order to advance the standardization of QC in the basic enterprises and to control variation in quality within permissible limits. For example, at a job site where several workers wire and assemble electric motors, the work methods of their simple handwork were actually inconsistent.

It goes without saying that increasing the effective work load and absorbing surplus labor is fundamental, but can that surplus labor not be used in the collection of necessary QC data, the preparation of graphs, process capability index and control charts, and in the search for ideas on improvement of the work site? To do so, basic worker education is necessary. It can be predicted that the skill level of the general work force will be a problem. Even though time is required for education, it is unavoidable to some degree. It is far better than allowing the present situation. Work standardization will not advance as long as non-controlled surplus workers are not eliminated from the work site.

I see that one key to whether China's future QC becomes deep-rooted and develops lies in this problem. As can be gathered from the content of the questions listed above, China looks at QC by classification of industry (machinery, steel, electrical/electronic, chemical, textile). Expertise and knowhow were apparent in the question and answer sessions. In connection with this characteristic, I feel they are apt to pursue an already established structure or system. Relying on the example of Japanese enterprises, they establish a TQC promotion area and build a quality guaranteed system, but the explanation of what kind of progress was experienced and what kind of improvement was accumulated in the construction of the present structure and system is apt to be forgotten. That is natural since they are in the midst of pressing forward with modernization. But it is important to recognize that the best and fastest way to progress is not to grab at a system like rice cakes in a painting (it is necessary to understand through knowledge), but to make the present system of their own factories the basis, then analyze what kind of deficiencies there are and what kind of problems are occurring, then steadily set up a cycle of improvement and standardization, and gradually achieve a high level system.

Expansion of Enterprise Autonomy and Quality Control

On my visit to China this year, I felt that a special characteristic was the connection between expansion of enterprise autonomy and the promotion of QC.

In order to let independent, long-lasting QC activities take root from QC executed by directive from above, it is necessary that each enterprise receives the results of QC and all personnel in the factory actually savor the feeling that "it really is good to put QC into practice." Just as Sichuan Province (Chengdu), which I visited this year, is called a spectacular testing ground of China's modernization, I heard many stories connected with the expansion of enterprise autonomy. I felt that this will be a great influence on the development of future QC activity. It is said that Sichuan province has a geographic area of 560,000 square kilometers and a population of 97 million. It has long boasted of being a "land of plenty," with rich agricultural production. It is a well known fact that Premier Zhao Ziyang produced excellent results in his provincial leadership of Sichuan and took the lead in the expansion of enterprise autonomy. About 10 percent of the 3,300 national trial enterprises were in Sichuan.

The China delegation visited Chengdu Measurement and Cutting Tools Plant where 5 percent of the planned profit and 20 percent of the excess profit of the previous year's profits can be used for bonuses, welfare facilities and expansion of production facilities at the factory's own judgment. When such is provided, the willingness to actively study and put QC into practice themselves and to produce results is heightened. At the trial enterprises, it is said the right is given to look for consumers and sell products produced in excess of the government directed production plan on their own. Each enterprise employs its own salesmen, visits its users and makes an effort to expand the market; the gap between production plant and user is reduced. This is one step forward in resolving the problem of information feedback on quality from users. I heard that there is a plan to set up service shops with repair parts in some of the machine product enterprises in order to improve the user satisfaction level.

Coupled with the activity of expanding enterprise autonomy, improvement of user satisfaction level, market and the intent to develop new products and all-out development of QC were steps forward. These can be offered as characteristic of China's QC this year in comparison with last year.

Postscript

When the delegation visited Beijing, Nanjing, Hangzhou and Shanghai in September 1979, it was immediately after various factories had begun to study and apply QC at the directives of the Central Committee. The ordinary pattern of execution in each factory was: 1. arranging and putting everything in order within the factory premises and work site; systematically producing and shipping products of good quality in accordance with the production plan; giving consideration to the work site environment and safety; promoting improvement, that is to say, making modern production the goal; 2. Persons who had studied and learned at the QC model factories in Beijing and from Japanese QC experts took charge of QC education; introductory QC education was started with plant management, engineers and then workers; many examples of ways of extracting and using basic statistical methods with use of blackboards, bulletin boards and leaflets inside the factory were noticeable; 3. QC model work sites were set up in the factory and QC team activity started. Work site teams, in which political study had been the nucleus until now, adopted the study of QC. Many examples were seen in which management supervisors, engineers and workers cooperated and promoted QC. As for the means

of furthering QC at the time of its introduction, it can be called reasonable on the whole. On the other hand, while going around to the various factories, I felt that at the time there existed the following misunderstandings and lack of understanding: 1. QC is a panacea, so any kind of problem can be immediately solved with QC; 2. QC is unnecessary in the case of expert technology and specific technology; 3. The use of such statistical methods as the control chart and process capability index is QC; 4. Quality improvement should rigorously implement inspection (self inspection and expert inspection).

Compared to the previous year, last year each factory, having gone through the experience of one year, had started to look for a QC system adapted to itself. I feel that they have finally planted their feet firmly on the ground. However at the same time, given the fact that the results until now are, as it were, from arrangements prior to QC, it seems that they are very anxious for business guidance on how QC can be promoted from now on. A somewhat wide variation in the degree of understanding and promotion of QC between factories is noticeable. I think the tendency for such wide variation between factories, coupled with a movement toward expansion of enterprise autonomy will gradually become more impressive in the future. As for the opinions of the members of the China delegation this time, on the one hand there is the viewpoint that, concerning the present situation of China's QC observed by us, "they are too quick to learn QC by watching others. Should they not thoroughly strengthen their basis?" On the other hand, there is the opinion that "at any rate, what has been achieved in the present level in 2 years (even though there is a wide variation between factories) must be given a high assessment compared to the situation at the time of Japan's introduction of QC." In discussing the present situation of China's QC, since China has an immense geographic area and extreme diversity, there can be no simple conclusions with a Japanese-like impetuosity. The only thing I can say with confidence is that logical consideration of QC and methods of promoting work are valid software of an enterprise's control, regardless of the national economic system, race, history, religion, language, manners and customs or living environment, and are extremely important for deepening mutual understanding. I have felt deeply the need to increasingly enlarge and strengthen the pipeline of QC exchange between Japan and China. (Motomu Baba, Komatsu, Ltd, director of personnel, chief instructor of QC; born in Tokyo in 1926, entered Komatsu, Ltd in 1954.)

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FINANCE AND BANKING

BALANCED BUDGET URGED: FINANCIAL DEFICITS OPPOSED

Beijing CAIZHENG [FINANCE] in Chinese No 2, Feb 81 pp 8-11

[Article by Wang Shaofei (3769 4801 7378): "It Is Crucial That We Eliminate Financial Deficits"]

[Text] Whether revenue and expenditure are balanced, a question affecting the overall national economy, deserves our close attention and must be tackled seriously. To issue currency to meet huge financial deficits is bound to give rise to currency devaluation, rising prices, drop in real wage and hardship on the people's lives. This is an objective law not amenable to the subjective will of man. To act in accordance with the objective law of economics, the very first thing is to defend balanced revenue and expenditure, eliminate financial deficits, strive to balance revenue and expenditure, work for unobstructed execution of the readjustment of the national economy, stabilize commodity prices and protect the livelihood of the people.

Marx pointed out: "The most crucial question in a budget is to figure out the ratio between revenue and expenditure, to prepare a balance sheet of surplus or deficit which determines whether the state should reduce or increase taxes." (1) According to the Marxist principle, the state budget we prepare should be governed by the principle of balanced revenue and expenditure, instead of deficit budgeting. In commenting on budgeting in capitalist countries, Marx said: "The state administration would not serve the interests of national production unless its budget is balanced and its revenue and expenditure are balanced." (2) We have no doubt that the administration of a socialist state works for the interests of the people, and its economic policies are based on the interests of the people. Huge financial deficits, however, are detrimental to the economic interests of the people and hamper projects to improve their livelihood. The following are my views on the negative impact of financial deficits, the causes of recurrent financial deficits and the measures to eliminate them.

1. Financial deficits are a negative factor in the development of the national economy.

The current opinions on the financial deficits are divided between the theorists and the practical working sectors. Some comrades say that in spite of a 17-billion financial deficit in 1979, the national economy fared splendidly. Isn't the success due to financial deficits? I think this is incorrect. The achievement of 1979 in the economic field is not due to any positive impact of the financial

deficits. The success is brought about by attacks on the "leftist" errors in the economic construction launched after the Third Plenary Session of 11th CCP Central Committee and by the 8-character principle of readjustment it proposed and the measures to execute the readjustment. It has nothing to do with the financial deficits. Had the readjustment of the national economy in 1979 been effective enough to cut back more decisively the capital construction investments when we readjusted the requisition price of farm products and increased the wage of staff and workers, our economic situation would have been even better. We might have had a surplus out of balanced revenue and expenditure, and gained back our economic initiative instead of shouldering such a heavy load. The impact of the financial deficits of 1979, if any, is to hold back our progress and aggravate our difficulties. To eliminate the financial deficits and balance revenue and expenditure is one of the objectives of the readjustment of the national economy. Any attempt to use financial deficits to readjust the ratios in the national economy could only aggravate the dislocation of such ratios. The impact of financial deficits on the development of the national economy is negative, and not positive.

1. Financial deficits disrupt the ratio between production and consumption and that between accumulation and consumption. Financial revenue and expenditure represent the process of distributing the surplus product value newly created in the current year. Revenue and expenditure reflect not only the relationship between production and consumption but also that between accumulation and consumption. In a commodity economy the distribution of the products of society is done through the medium of value, although distribution by means of financial revenue and expenditure does not cover all the product value. What falls within the limits of financial revenue and expenditure is only a part of the surplus product value, the only product value available for meeting the common needs of society, for the accumulation of funds, for social production and consumption funds as well as the individual consumption requirement of workers engaged in non-material production. It is the only source of the accumulated funds and a major component of the consumption fund. A departure from this process of distributing the surplus product value, a departure from the financial system of revenue and expenditure, would render the ratio between production and consumption and between accumulation and consumption meaningless. Accumulation and consumption are an economic process consisting of a multitude of factors of which financial revenue and expenditure play a decisive role. When financial revenue and expenditure are out of balance with expenditure going over revenue and huge financial deficits, it means the distribution exceeds the production of the year in question, and that the value distributed exceeds the value newly created during the year. It is like distributing a value not yet created or asking people to consume products not yet produced. This leads to a dislocation of the relationship between production and consumption. When a large part of the expenditure is invested in capital construction, it would make the scale of the capital construction overrun the currently available material resources and arrest due improvement of the livelihood of the people, or even lower their standard of living. This would inevitably distort more seriously the ratio between production and consumption and that between accumulation and consumption.

2. Financial deficits are an important factor which shatters the balance between supply and demand. A widely accepted law of the commodity economy is to maintain a balance between supply and demand. In a commodity economy, the people buy what

they need for living from the market where the products manufactured by the enterprises are sold. The seller and the buyer, the producer and the consumer, should maintain a necessary equilibrium. When the commodity offered for sale by the producer exceeds the demand of the consumer, there would be a surplus of commodities and a sluggish market. When the demand of the consumer exceeds the commodities a producer can supply, it will result in supply falling behind demand and panic buying. A sluggish market due to surplus commodities or panic buying due to supply falling behind demand are manifestations of an economic crisis. These two phenomena could occur simultaneously in a capitalist society. The ability to pay for what one needs in a capitalist society depends on employment opportunities and the price of labor. When employment opportunities are good and the price of labor is high, the demand for commodities will increase. On the other hand, if employment opportunities are poor and the price of labor is cheap, the demand for goods which people can afford to pay will drop. The amount of commodities supplied to society is determined by the individual producers according to the market situation. Consequently, production by the capitalist enterprises fluctuates with the changes in the market. This is called the adjustment of supply and demand. Although the capitalist system of state finance can adjust to a certain extent the supply-demand relationship in a capitalist society through government order for goods to help the enterprise to increase production and increase the ability to pay, it has no decisive influence on its supply-demand relationship. Unlike capitalism, the socialist system of public ownership of the means of production makes the socialist system of finance a decisive factor in the supply-demand relationship. The goods demanded which the people are able to pay in a socialist society depends mainly on the distribution process of its finance system. Except for wage and bonuses paid by the enterprises to workers engaged in commodity production and the income of commune members, the greatest part of the production investment, social consumption and the personal consumption of workers engaged in nonmaterial production are handled through the distribution process of the financial system. Balanced financial revenue and expenditure indicates an overall coordination of distribution and production and a balance between the demands people are able to pay due to financial expenditure and the amount of commodities which society could provide. Substitutes or rebuilt goods could be used to meet the shortage of any particular item in demand. Shortage of supply limited to a locality or any particular item is not likely to lead to social disorder. On the other hand, unbalanced financial revenue and expenditure, huge financial deficits and distortion of the ratios of expenditures will disrupt the whole supply-demand relationship and bring chaos to the circulation process. In flated purchasing power brought about by financial deficits, therefore, are mainly responsible for market disturbances and imbalance of supply and demand.

3. Financial deficits are mainly responsible for currency devaluation and rising prices. The financial revenue and expenditure, manifested in the movement of funds in currency, are directly related to currency circulation and commodity prices. Generally speaking, when revenue and expenditure are balanced and the amount of currency in circulation keeps pace with the development of production, both the value of the currency and commodity prices would remain stable. When financial expenditure overruns revenue so as to cause financial deficits while there is no reliable source of revenue to fall back on, the only available remedies are to resort to bank overdraft and the issuance of more currency. The currency issued to meet financial deficits is an inflated currency distributed in excess of the production of the current year. Not backed by material resources, the amount of the

currency in circulation would overrun the actual amount of production and force the true value of a currency unit to drop, leading to currency devaluation and rising prices. The rising prices will increase financial expenditure and incur more deficits, a vicious circle.

Our financial and economic foundation is so weak and the standard of living of our people is so that our capability to withhold financial deficits is extremely limited. Since the state is unable to raise the wage of the staff and workers fast enough to keep pace with rising prices, they have very little tolerance for price fluctuations. Financial deficits continued year after year lowers the actual standard of living of the people. To raise prices to offset the financial deficits caused by the issuance of currency means to lower the real wage to boost the capital construction investment.

In a word, economic instability and market confusion brought about by financial deficits in a socialist society generate popular disillusion and criticisms instead of enthusiasm and zeal. This is detrimental to the readjustment of the national economy and reform of the economic structure.

11. The causes of recurrent annual financial deficits

Financial deficits which do not have any positive impact on the development of the national economy must not be placed on a par with economic achievements. However, no country can avoid financial deficits altogether, nor can it guarantee that it will not run into financial deficits for any length of time. Any country may run into financial deficits due to political reasons, natural calamities or policy errors. What we mean by eliminating financial deficits is to avoid deficit budgeting when we prepare our state budget, and adopt effective measures to eliminate or reduce them or shorten the duration of such deficits as soon as they are spotted.

To eliminate the financial deficits, we must analyze the causes of recurrent annual financial deficits. The unprecedented financial deficits of 1979 were due to a multitude of causes. "The earth does not freeze 3 feet deep in 1 day." Personally I believe, in addition to the disruption by Lin Biao and the "gang of four" which drove our national economy practically to the brink of disaster, there are three more reasons, as follows:

1. For a long time, especially since 1958, our economic construction was permeated with errant "leftism," unrealistic, unnecessarily grandiose and preoccupied with excessive quotas. Under the guidance of the "leftist" ideology, the policy was for high rate of accumulation and low rate of consumption, the higher the accumulation rate, the bigger the scale of construction, and the faster the pace of development the better. Thus our construction scale is always out of line with the true conditions of our country and available financial resources. The impact of this kind of errant "leftism" is mainly responsible for the huge financial deficits which cannot be readily eliminated.

Still low in productivity, the surplus product value we create each year is very limited. We must distribute this limited surplus product value rationally in order to raise, even though slightly, the living standard of the people and still proceed

with the economic construction. The annual rate of accumulation should be realistic and affordable. "Do only as much as we have money to pay." We must not indulge in blind pursuit of expanding scale of construction and high rate of accumulation which are incompatible with our available financial resources. Since financial revenue and expenditure are the vehicles for distributing the surplus product value, all expenditures should be in keeping with the economic functions of the latter. Maintain the status quo before seeking expansion; provide daily necessities before pursuing capital constructions. Any commitment of investment to capital construction and its expansion irrespective of available revenue in violation of this order of priority and without providing funds needed for maintaining the status quo and raising the standard of living of the people would inevitably push expenditure over revenue and end in financial deficits. Actual practice tells us the policy of high rate of accumulation and low rate of consumption leads to disappointing economic results. The recurrent annual financial deficits we have now are the result of this policy that was carried out all these years.

2. The need to balance revenue and expenditure and avoid financial deficits is not fully appreciated. In 1977 and 1978, following the overthrow of the "gang of four," there were still unrealistic slogans asking for higher rate of accumulation in spite of the economic difficulties brought about by the 10 years of calamity. This aggravated our financial difficulties. In spite of the corrections made by the Third Plenary Session of 11th CCP Central Committee, the need to balance financial revenue and expenditure is still not fully appreciated, due to the impact of the policy of high accumulation rate and low consumption rate which prevailed in 1977 and 1978. In the past, the plea to mind the limitations of our financial resources and the need to act within our means was branded and criticized as ideological conservatism, while the attempt to balance the financial revenue and expenditure was regarded as a roadblock to the development of production. Some even alleged that reduction of investment in capital construction is "a rejection of the four modernizations." Those who drew up the national economic plans did not base the construction scale on currently available financial resources. They forced the financial revenue and expenditure to conform to their subjective visionary scales of construction and allowed revenue and expenditure to get out of control. As a result, the financial revenue and expenditure structure became a mere negative indicator of the fixed quotas in the national economic plans. To preserve the fast pace prescribed in the national economic plans, the financial revenue and expenditure were often forced to aim at higher quotas and operate under extreme pressure.

3. The third cause of recurrent huge annual financial deficits is mistaken policy and ineffective readjustment. After the overthrow of the "gang of four," due to lack of understanding of the errant "leftism" in our economic construction, we did not act fast enough to rectify the mistaken policy already carried. In fact, after the overthrow of the "gang of four," we should have allowed the seriously disrupted national economy enough time to recover, go through the required readjustment and let the people take time to recuperate before pursuing new constructions. Instead of doing all these, we came up with so many unrealistic slogans that the national economy was forced into a more passive position. By the time these policy errors were discovered, the reintroduction of an 8-character policy based on readjustment was too late to save the worsening passive situation and stop those construction projects already in progress. The resulting heavy financial liability and the failure to achieve the expected result of the readjustment due to ineffective implementation are responsible for the huge annual financial deficits.

In fact, the readjustment of the national economy should have begun to draw on the strength of one to offset the weakness of another by shutting down, suspending, merging and transferring the enterprises rather than tolerating the existing conditions and following the established routine. If we were afraid to trample upon the interests and rights of anyone during the progress of the readjustment, we would have to face the economic consequences and hardships brought about by financial deficits.

III. The measures required to eliminate financial deficits and balance revenue and expenditure.

The current financial deficits differ somewhat from those of the past. Since these huge annual financial deficits were built up over a long period, slogans such as more production, austerity and reduction of the collective purchasing power are not enough to eliminate the current financial deficits. More drastic measures are required to put an end to the existing condition.

1. A major step leading toward eliminating the financial deficits and readjusting the distorted ratios in the national economy is to cut back capital construction investments. The distorted ratios in the national economy are brought about mainly by excessively high accumulation rate, excessively low consumption rate and too much accumulation fund committed to capital construction investments. This is the principal cause of the financial deficits, and the only way to put an end to the existing economic plight is to drastically cut back capital construction investments. The estimated capital construction investments in 1980 will go over 50 billion yuan, way over the 1979 capital construction scale. This no doubt will increase the financial deficits of 1980. If the estimated budget of 1981 does not restrain capital construction investments, huge deficits are bound to occur. If we indulge blindly in uncontrolled capital constructions in the face of annual financial deficits, our national economy will be in serious trouble. This must be stopped. The capital construction projects must be placed under strict control. Scrap, stop and postpone a part of the projects. At the same time, the funds owned by localities and enterprises should be brought by appropriate means into the orbit of the readjustment program, and no additional projects should be permitted. This will lead to certain economic losses which are much less harmful than the growing financial deficits, and hasten the readjustment program.

2. Another major step to reduce the financial deficits and stabilize the circulation of currency and commodity prices is to tighten bank credit. When financial deficits occur, bank credit must be tightened. If a bank overdraft were used for meeting financial deficits and the bank did not tighten its credit, it would have to issue more currency. This would lead to inflation and the end-result could be serious indeed. When huge financial deficits are building up, the People's Bank must stop extending capital construction loans and place strict control over loans to cover the operating funds of any enterprise. This is the only way to reduce financial deficits and slow down currency devaluation.

3. Due to the extension of the financial power of the enterprises and localities, they have more liquid funds at their disposal. How to make proper use of such liquid funds is a very serious problem confronting the readjustment of the national economy. If the localities and enterprises were allowed to invest to meet their

own needs and for their own benefit, they would act so blindly as to duplicate constructions, extend the line of capital construction and strain the supply of raw materials. But, it is unwise to ask them to turn back the clock and kill the enthusiasm of the localities and enterprises. The best approach is to persuade them to channel their liquid funds to areas urgently required for readjusting the national economy. It might be wise to use joint investment or issuance of shares to guide the funds owned by the localities and enterprises to unified capital construction projects, so as to form joint enterprises of both central and local authorities, a new form of socialist public ownership.

4. Our economic reforms should proceed with comprehensive modular planning, including the forms of public ownership, system of planning, price system, financial system, banking system, commercial system (including the supply of the means of production), labor system, wage system, information and supervision systems and the connections and mutual relations between these systems. Such a plan to make our economic reforms more systematic and methodical would enable us to predict and prevent many problems likely to arise during the progress of the reforms. This would contribute substantially toward stabilizing financial revenue and expenditure and eliminating financial deficits.

In a word, the most urgent task for the elimination of the financial deficits is to balance revenue and expenditure, which could be accomplished in the year 1981, provided we realize the seriousness of the problem and have the resolve to tackle it. If this were done, we would speed up the readjustment, reduce economic losses, avoid unnecessary hardships and help the four modernizations materialize much sooner.

FOOTNOTES

- (1) "Complete Works of Marx and Engels" Vol 9 p 67
- (2) Ibid, vol 7 p 13

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CSO: 4006

ENERGY

CARTOON PORTRAYS SCIENCE FICTION APPLICATION OF SOLAR POWER

Beijing TAIYANGNENG [SOLAR ENERGY] in Chinese No 1, 1981, inside front and back cover

[Article: "The Flying Umbrellas"]



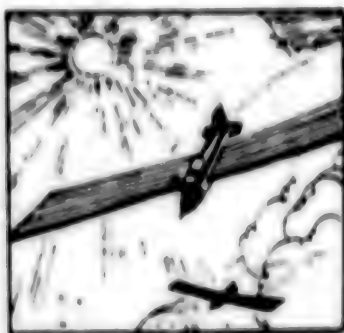
[Text] (1) The crack "Flying Umbrellas" are armed with the latest solar energy technology. The flying umbrellas with which the unit is equipped are actually multipurpose combat weapons. During one flight, A Squad used the solar energy detectors on the umbrellas to discover that the enemy had secretly set up a missile base in Region 502, between the mountains and the sea. Upon their return, the squad leader reports to headquarters.



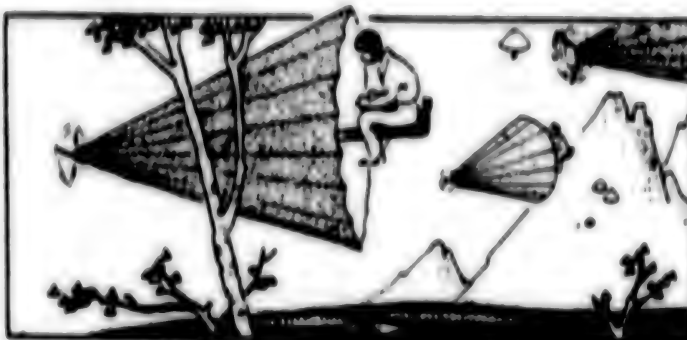
(2) A Squad is ordered by HQ to prepare for action, then to wait for an opportunity to penetrate enemy lines and destroy the missile base. Led by the squad leader, the men make careful preparations.



(3) A few days before the attack, Dr Sigma, of the Energy and Botany Institute, delivers some fast-growing algae which can be air-dropped. This algae has a particularly high utilization rate of solar energy so it grows large very quickly. Dropping it into the sea around the enemy will help to support the assault.



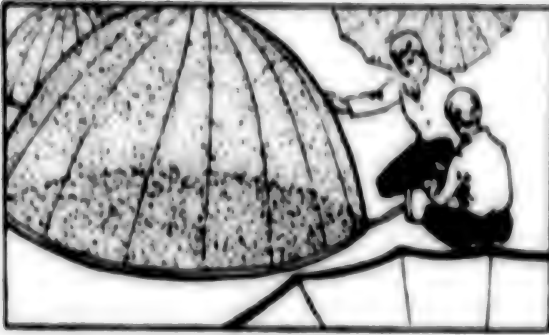
(4) The 16th of November is clear and completely cloudless. The nine fully armed men of A Squad board two solar powered aircraft and fly toward the enemy positions.



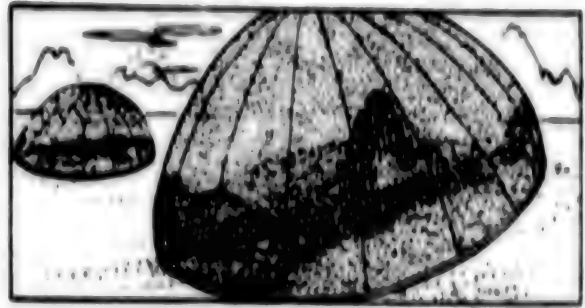
(5) Approaching the enemy positions, the men leap aboard their umbrellas and immediately take off at extremely low altitude. The umbrellas are semi-deployed, and, powered by their solar energy powerplants, they advance swiftly.



(6) After the umbrellas arrive at a pre-designated valley in the enemy's rear, the squad leader orders all hands to land and take a rest. While resting, the men open their umbrellas to act as high energy power sources to recharge their batteries. They also use the umbrellas to fix a meal. The surface of the umbrella is made of thin film, solar energy batteries. The reverse side of the umbrella is highly polished so that it can be inverted to act as a solar cooker.



(7) At dusk, the squad leader orders everyone to quickly put the umbrellas down and inflate them. In an instant, the umbrellas become so many tents, which from afar resemble yurts on the plains.



(8) Even though it was only early winter, the evening felt cold. But because the umbrellas are covered with a special S-20 coating which retains heat extraordinarily well, and the men have donned solar energy clothing which gradually releases the solar energy stored up during the day, it is very comfortable in the tents and the men sleep soundly.



(9) When his men have gone to sleep, the squad leader resumes checking over the operation maps. A "solar light strip" capable of absorbing solar energy provides the illumination.



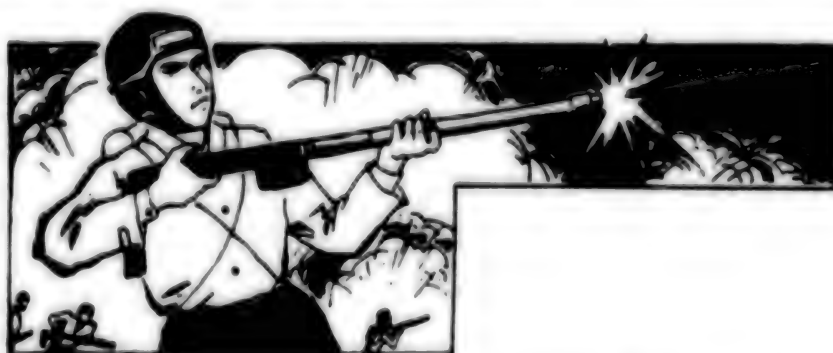
(10) Before dawn, the solar energy communicator brings orders from headquarters, and the squad leader uses his watch-type walkie-talkie to tell his men to get up immediately and prepare for action.



(11) The men fold up their tents, deploy their umbrellas and switch on the high energy electric source. The flying umbrellas half fly, half crawl along the mountain slopes. Crossing the steep crest of the mountain, they quickly approach the outpost in front of the enemy base.



(12) The men take cover near the outpost. When broken down, the umbrellas' components become powerful solar energy laser guns.



(13) The lasers flash, and the enemy drop like flies. In a short time, all the enemy personnel in the outpost are annihilated.



(14) As they advance, an enemy pillbox blocks their way. The squad leader orders his men to destroy the pillbox with their solar energy oxyhydrogen flame-throwers. In an instant, clouds of heavy smoke rise from the pillbox and explosions shatter the air.



(15) Having wiped out the obstacle, the men continue their headlong rush toward the enemy's missile base, screened by the morning clouds.

To be continued....

CSO: 4006

RESEARCH ON OIL-WATER MOTION IN EAST CHINA'S OIL-WET RESERVOIRS

Beijing SHIYOU XUEBAO [ACTA PETROLEI SINICA] in Chinese No 3, Jul 80 pp 33-47

[Article by Han Dakuang [7281 1129 0562], Huan Guanren [2719 0385 0088] and Xie Xingli [6200 5281 4409], all of the Scientific Research Institute of Petroleum Exploration and Development, Beijing: "Numerical Simulation Study of Water-Flood Performance in a Stratified Oil-Wet Sandstone Reservoir"]

[Text] I. Introduction

The major oil reservoirs in the eastern part of our country are continental sedimentations characterized by extremely grave heterogeneity. Within a given reservoir, the vertical permeability difference can reach as much as several tens of times. From flood plains, distributary plains to the uprake parts of deltas, sedimentations of land facies river delta systems formed into reservoir sand of different kinds of structures under various sedimentation conditions. For example: River bed sandstones of remarkable positive rhythmic features often formed in the main stream lines of flood plain river courses; as the rivers flowed into the distributary plains, the water courses began to slow down and divert into multichannels, often forming into composite positive rhythmic reservoirs composed on more than two superimposed time units. Typical negative rhythmic reservoirs often develop in constructive deltas. In different types of reservoirs with different kinds of structures, the oil-water displacement also varies in pattern. Based on field data from Daqing and other oilfields, the waterflooding characteristics of reservoirs can be divided into the following categories:

1. Bottom Water-Out Type:

All positive rhythmic reservoirs fall in this category; the injected water invades along the high permeability interval of the reservoir bottom. According to coring data, the water-out depth is generally very shallow. Breakthroughs occur early, the water content rises rapidly. Thus, the recovery rate is relatively poor.

2. Interval Water-Out Type:

This type of reservoir is generally characterized by superimposed composite positive rhythmic oil layers. Water scrubbing is conducted vertically upwards

in the reservoirs, and the washing occurs right at the bottom of each rhythmic interval. This type of reservoir does not have great water-out depth index either. The water-out depths in the lower rhythmic intervals are generally greater than those in the upper rhythmic intervals.

3. Uniform Water-Out Type

This type of reservoir is either fairly thin or negative rhythmic or of low permeability. The water-out depth index is fairly great, and oil displacement efficiency is fairly uniform throughout the reservoir.

From above, it can be seen that the heterogeneity of reservoir structure and reservoir permeability exerts tremendous influence on oil-water motion inside the reservoir. Besides, such factors as reservoir wettability, oil-water viscosity ratio, permeability absolute value and reservoir thickness can also exert varying degrees of influence.

In foreign countries, quite a few articles have been published on the mechanism of oil-water displacement in heterogeneous water-wet reservoirs. But there are very few reference materials on oil-wet problems. As the reservoirs in Daqing Oilfield and some oilfields in East China are oleophilic, it is of tremendous importance, both in the theoretical aspect and practical aspect, to study the oil-water displacement mechanism inside oil-wet reservoirs.

II. Numerical Simulation Method

The mathematical models presented in this article consist of oil-water two-dimensional two-phase flow equations which include such factors as gravitational and capillary forces.

$$\begin{cases} \frac{\partial}{\partial x} \left[K(x, y) \frac{K_{ro}(s)}{\mu_o} \frac{\partial \Phi_o}{\partial x} \right] + \frac{\partial}{\partial y} \left[K(x, y) \frac{K_{ro}(s)}{\mu_o} \frac{\partial \Phi_o}{\partial y} \right] = -\phi \frac{\partial s}{\partial t} \\ \frac{\partial}{\partial x} \left[K(x, y) \frac{K_{rw}(s)}{\mu_w} \frac{\partial \Phi_w}{\partial x} \right] + \frac{\partial}{\partial y} \left[K(x, y) \frac{K_{rw}(s)}{\mu_w} \frac{\partial \Phi_w}{\partial y} \right] = \phi \frac{\partial s}{\partial t} \\ P_c(s) = \Phi_o - \Phi_w + \Delta \rho g h \end{cases}$$

in which, K -- absolute permeability;

ϕ -- porosity;

K_{ro} , K_{rw} -- relative permeabilities of oil, water phases;

μ_o , μ_w -- viscosities of oil, water;

Φ_o , Φ_w -- flow potentials of oil, water phases;

s -- water saturation;

g -- gravitational acceleration;

$\Delta \rho = \rho_w - \rho_o$ -- difference between water and oil densities;

h -- height difference from oil/water interface

P_c -- capillary pressure

As early as the late 1950's, there was already some literature on the numerical simulation study of two-phase flow of oil and water.¹ But the research on this type of nonlinear equation system computing method is still continuously being improved. In solving this type of problem, the authors of this article have found a linearized processing method that is comparatively satisfactory. It is characterized by quick convergence, excellent stability, and high rate of accuracy. Its basic philosophy lies in the application of "segmented linearization" technique to break the capillary pressure curve into a number of intervals and replace curvilinear arcs with broken lines. The following linear relation between water saturation S and capillary pressure P_c is maintained within each interval:

$$S = aP_c + b$$

in which, a and b are the slope and intercept of a broken line segment, and each interval has its own corresponding set of values.

This transforms the difference equation into a linear algebraic equation system.

$$\begin{aligned} & \alpha_{1,j+1}(\Phi_{n,j+1} - \Phi_{n,j}) + \alpha_{1,j}(\Phi_{n,j} - \Phi_{n,j-1}) + \alpha_{1,j-1}(\Phi_{n,j-1} - \Phi_{n,j-2}) \\ & + \alpha_{1,j-2}(\Phi_{n,j-2} - \Phi_{n,j-3}) + q_0 = - \frac{\Phi \Delta x \Delta y}{\Delta t} [a(\Phi_{n,j} - \Phi_{w,j} + \Delta \rho g h) \\ & + b - S_{1,j-1}^{n-1}] \beta_{1,j+1}(\Phi_{w,j+1} - \Phi_{w,j}) + \beta_{1,j}(\Phi_{w,j} - \Phi_{w,j-1}) \\ & + \beta_{1,j-1}(\Phi_{w,j-1} - \Phi_{w,j-2}) + \beta_{1,j-2}(\Phi_{w,j-2} - \Phi_{w,j-3}) + q_w \\ & = \frac{\Phi \Delta x \Delta y}{\Delta t} [a(\Phi_{n,j} - \Phi_{w,j} + \Delta \rho g h) + b - S_{1,j-1}^{n-1}] \end{aligned}$$

in which

$$\alpha_{1,j+1} = \frac{\Delta x}{\Delta y} K_{n,j+1} \left(\frac{K_{r,n}}{\mu_n} \right)_{1,j+1}^{n-1}, \quad \alpha_{1,j} = \frac{\Delta y}{\Delta x} K_{n,j} \left(\frac{K_{r,n}}{\mu_n} \right)_{1,j}^{n-1}$$

$$\beta_{1,j+1} = \frac{\Delta x}{\Delta y} K_{w,j+1} \left(\frac{K_{r,w}}{\mu_w} \right)_{1,j+1}^{n-1}$$

$$\beta_{1,j+\frac{1}{2}} = \frac{\Delta y}{\Delta x} K_{1,j+\frac{1}{2}} \left(\frac{K_{r,w}}{\mu_w} \right)_{1,j+\frac{1}{2}}^{n-1}; \quad \dots$$

K_x, K_y -- horizontal and vertical permeability,

q_0, q_w -- well point oil, water phase production (or injection volume)

In solving the equations by the iterative method, it is imperative to choose a and b intervals which are correspondent to ϕ_o and ϕ_w (oil, water phase potentials). For this purpose, a programming method has been devised for conducting successive comparison of the intervals; the corresponding intervals can be found after a couple of comparisons. The line over-relaxation method is used for solving the difference equations system. The line is perpendicular to the reservoir. When using the relaxation formula, it is important that the potential difference between the oil and water phases should remain unchanged before and after the relaxation so as to prevent the relaxation from affecting the computation of S value.

Stable and reliable results can be achieved in either water-wet or oil-wet models through the preceding processing methods no matter how great the variation range of computation parameters may be. As far as ensuring the mass conservation is concerned, the error is kept within 0.001. Moreover, there is only a minimal amount of iterations and computing work involved. The high level of accuracy is verified by comparing the result of numerical simulation with the analytical solution. Comparison also indicates that the computation results tally fairly well with the recovery test data.

Parameters and curves representative of the oilfields in the eastern part of our country are chosen as the basic parameters of the model. See Table 1 and Figure 1.

Table 1. Basic Parameters of the Model

Item	Numerical value
oil viscosity (centipoise)	9.0
water viscosity (centipoise)	0.6
water/oil density difference (gram/cubic cm)	0.2
water-oil interface tension (dyne/cm)	30.0
porosity	0.28
irreducible water saturation	0.16
remnant oil saturation	0.28
model length (meter)	500
annual oil recovery rate (percent)	3
maximum annual fluid yield rate (percent)	9

The following five similarity criterion numbers were used in the analyses of the computation results:

- (1) ratio between driving force and gravitational force:

$$\pi_1 = \frac{\Delta p}{\Delta \rho g H}$$

- (2) ratio between gravitational force and capillary force:

$$\pi_2 = \frac{\Delta \rho g H \sqrt{k_a}}{\sigma \cos \theta \sqrt{\phi}}$$

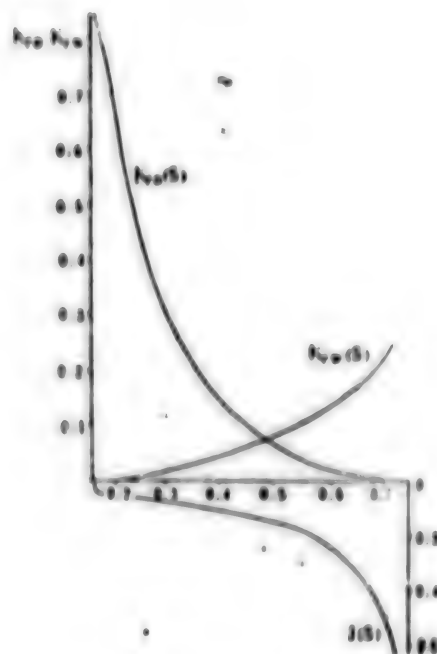


Figure 1. Relative Permeability Curve and Dimensionless Capillary Force Curve

(3) ratio between oil and water viscosities:

$$\pi_3 = \frac{\mu_o}{\mu_w}$$

(4) product of the square of ratio between the reservoir's length and thickness and the ratio between the horizontal and vertical permeabilities:

$$\pi_4 = \frac{K_y}{K_x} \left(\frac{L}{H} \right)^2$$

(5) the distribution of dimensionless permeability:

$$\pi_5 = \bar{K}(\bar{x}, \bar{y})$$

In the preceding equations, Δp -- drive pressure difference; K_2 -- mean permeability; K_y , K_x -- vertical and horizontal permeabilities; H , L -- oil reservoir thickness, length; $\bar{K} = \frac{K}{K_a}$ -- dimensionless permeability; $\bar{x} = \frac{x}{L}$; $\bar{y} = \frac{y}{H}$.

Besides, relative permeability function and dimensionless capillary pressure function are both based on actual data from the oilfield.

Based on analytical study of Daqing and Shengli Oilfield data, the authors of this article have computed some 100 cases and gained some new understanding.

III. Main Points of Understanding

A. Influence of the Vertical Distribution of Reservoir Permeability

It can be seen from oilfield data that the vertical upward oil-water motion in the reservoir and the distribution of permeability are closely related to each other, which, in fact, reflects the influence of the similarity criterion number. The article presents five kinds of models which are fairly realistic: uniform model, positive rhythmic model, negative rhythmic model, composite positive rhythmic model, composite negative rhythmic model. The permeability distribution is shown in Figure 2. The reservoir lengths are all 4 meters. The computation results are shown in Table 2.

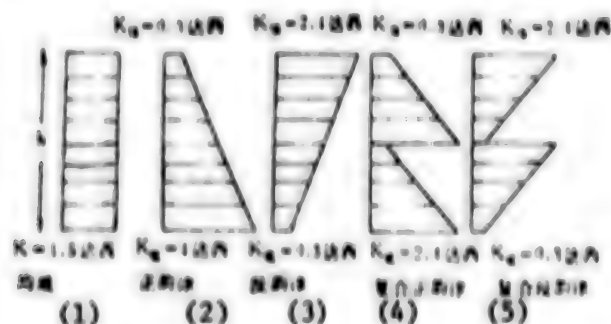


Figure 2. Schematic Diagram of Vertical Upward Permeability Distribution in Various Rhythmic Reservoirs

Key:

- | | |
|---|---|
| (1) uniform reservoir | $K = 1.5$ darcies |
| (2) positive rhythmic reservoir | $K_{top} = 0.3$ darcies
$K_{bottom} = 4$ darcies |
| (3) negative rhythmic reservoir | $K_{top} = 2.4$ darcies
$K_{bottom} = 0.3$ darcies |
| (4) composite positive rhythmic reservoir | $K_{top} = 0.3$ darcies
$K_{bottom} = 2.4$ darcies |
| (5) composite negative rhythmic reservoir | $K_{top} = 2.4$ darcies
$K_{bottom} = 0.3$ darcies |

From Table 2, it can be seen that the negative rhythmic model has the best recovery index; it is followed by the uniform model, composite negative rhythmic model and composite rhythmic positive rhythmic model in the given order; and the poorest one is the positive rhythmic model. The negative rhythmic model's water-free recovery rate and sweep thickness coefficient are two times higher than those of the positive rhythmic model, but its ultimate number of injections is only half of the latter. Thus, the waterflood efficiency of the negative rhythmic reservoir is much better than the positive rhythmic reservoir, and it is even superior to the uniform reservoir.

Table 2. Comparative Table of Recovery Indices of Various Rhythmic Models

Model	Item	Water-free recovery rate (percent)	Sweep thickness coefficient at break-through (percent)	Ultimate* recovery rate (percent)	Ultimate number of injections	Water injection efficiency coefficient (percent) **
Uniform		18.00	40.00	57.78	2.32	24.9
Positive rhythmic		11.63	27.50	51.38	3.57	14.4
Negative rhythmic		33.38	71.88	57.34	1.87	30.6
Composite positive rhythmic		12.75	35.53	51.29	3.09	16.6
Composite negative rhythmic		24.00	56.88	54.54	2.14	25.5

* Ultimate period is defined as 98 percent watercut

** waterflood injection efficiency coefficient = $\frac{\text{ultimate recovery rate}}{\text{ultimate number of injections}}$

What merits pointing out is the great difference between the oil-water motion mechanism of oil-wet media and that of water-wet media. Due to the capillary force, when water is injected into water-wet media, it can be drawn from the high permeability interval to the low permeability interval, and the oil can be driven from the low permeability interval to the high permeability interval, thus causing the oil-water interface drive between the high and low permeability intervals in the reservoir to be fairly uniform, which eases the influence of horizontal permeability difference on the oil-water displacement. But this is not the case in oil-wet media: In an oil-wet reservoir, due to the effect of capillary force on the heterogeneous interface, the water in the high permeability interval is prevented from entering the low permeability interval, which greatly enhances the influence of horizontal permeability distribution difference over the characteristic of oil and water motion.

From the waterflood profile (Figure 3), it appears that in all five models, water first floods the bottom portion. But the oil-water interface of the negative rhythmic reservoir is convex shape, while that of the positive rhythmic reservoir is concave shape. The composite positive rhythmic reservoir has multi-interval water-out patterns; the uniform model is similar to positive rhythmic reservoir; and the composite negative rhythmic model approximates the negative rhythmic reservoir. There are remarkable differences in their water-out thickness indices.

In a positive rhythmic oil-wet reservoir, due to the effect of gravitational and driving forces, the water flows downwards to the high permeability interval; but unlike water-wet media, the capillary force cannot draw the water from the high permeability interval at the bottom to the low permeability interval

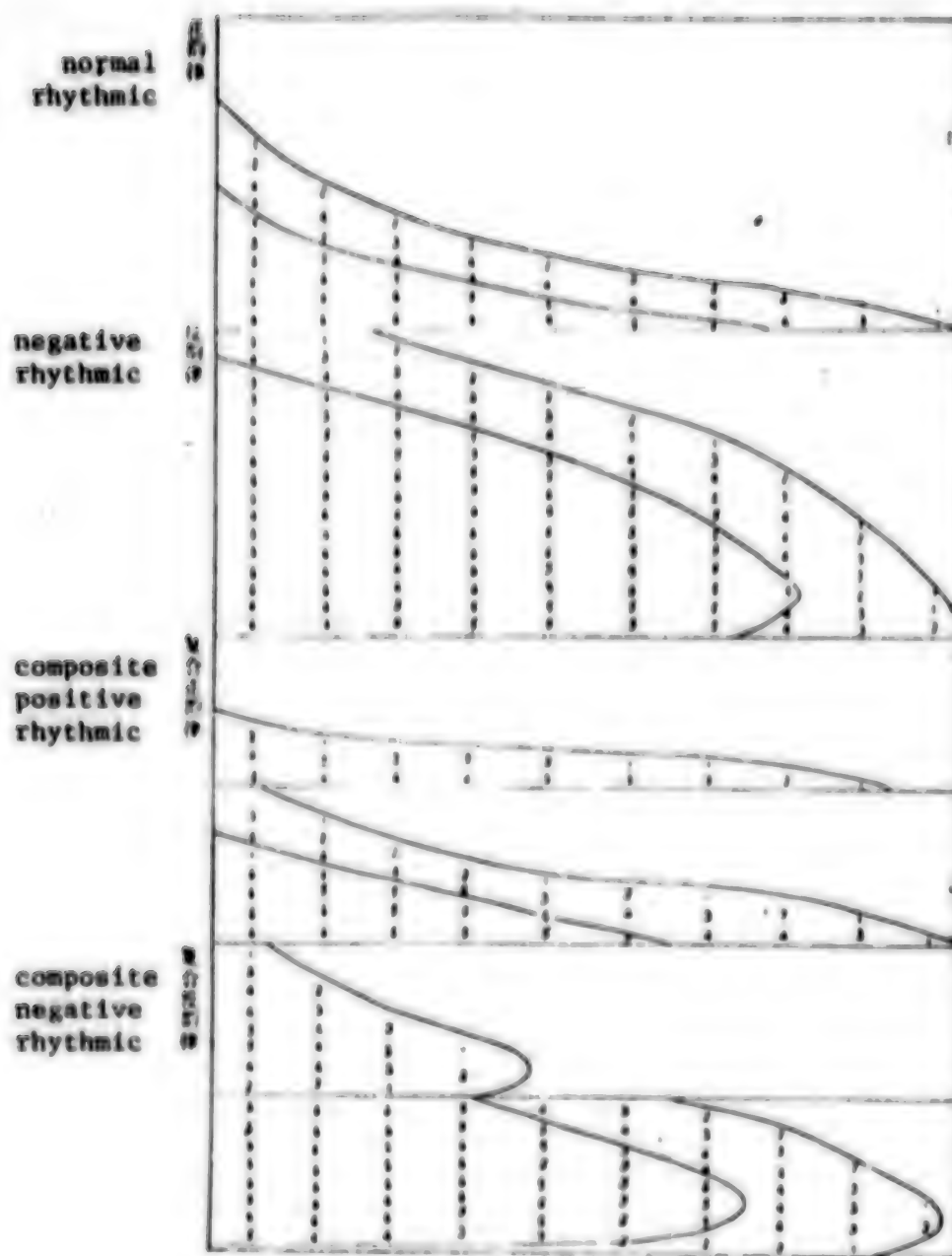


Figure 3. Waterline Chart of Different Rhythmic Models at Breakthrough

on top. As a result, massive water channeling occurs at the bottom. The water-line pattern is concave, the water channeling is swift, the sweep thickness efficiency is very low, and waterflooding produces poor results. In a negative rhythmic reservoir, the driving force makes water flow upwards to the high permeability interval, whereas the gravitational force tends to draw the water downwards; but due to the low permeability at the bottom, the water cannot flow freely, and, to a certain extent, the capillary force also prevents the water from sinking to the low permeability interval at the bottom. Thus, as the result of the combined action of the various forces, the negative rhythmic reservoir has an upward convex waterline pattern; its sweep thickness coefficient is greater, and waterflooding produces better results.

A composite positive rhythmic reservoir has multi-interval water-out patterns. This is caused by the capillary action of water-wet media. The water in each rhythmic section sinks to the bottom where the top portion of the lower rhythmic section consists of low permeability intervals. As a result, a capillary pressure difference is produced on the interface of the heterogeneous media, and gives rise to an upward force which prevents the water from sinking into the lower rhythmic section. It is only when the water saturation of the upper rhythmic section reaches a certain numerical level and balances the capillary forces on both sides of the interface of the heterogeneous media that the water can sink to the lower rhythmic section, thus producing multi-interval waterflooding. Due to the high level of water saturation in the upper rhythmic section near the injection point, some water is bound to escape from the upper rhythmic section to the lower rhythmic section. Thus, the waterlines in the lower rhythmic intervals generally advance at a quicker pace than those in the upper rhythmic intervals, and the water-out is relatively thicker in dimension. There are no multi-interval flood patterns in composite negative rhythmic reservoirs. This is attributed to the fact that the low permeability interval is above the heterogeneous interface while the high permeability interval is situated below the interface; moreover, both the capillary and gravitational forces run in the same direction. As a result, there is nothing to prevent the water from sinking downwards, and the waterline patterns are merged into a single section.

The result of the preceding simulation test coincides with the actual water-flood characteristics of corresponding structural reservoirs in Daqing Oilfield.

Before, it was widely believed that the heterogeneity of the reservoir was the primary cause behind the water channeling. This kind of interpretation has its limitations. The authors of this article do not believe it is possible to discuss about the reservoir heterogeneity problem in sweeping terms without regarding the type of reservoir structure in question, i.e., the characteristic of permeability vertical distribution. Instead, it is necessary to first examine the characteristic of the reservoir's permeability distribution. Within the same range of permeability variations, different types of reservoirs have completely different oil-water displacement characteristics. In the negative

rhythmic reservoir, it is possible to achieve greater waterflood thickness and excellent recovery results. Under certain circumstances, reservoir heterogeneity is not detrimental but conducive. However, the positive rhythmic reservoir is just the opposite case.

B. Influence of Permeability Grade Difference

In the preceding section, the effects of reservoir permeability vertical distribution were discussed from the qualitative aspect. In this section, the problem will be further treated from the quantitative aspect. First, we shall attempt to analyze the effects of the permeability ratio and thickness ratio of two-layer stratified models.

The permeability ratio is defined as: $\bar{K} = \frac{K_1}{K_2}$

The thickness ratio is defined as: $\bar{h} = \frac{H_1}{H}$

in which, K_1 , K_2 -- the permeabilities of high, low permeability intervals;
 H_1 -- the thickness of high permeability interval;
 H -- the overall thickness of the model.

In this article, dual-layer stratified models of positive rhythmic and negative rhythmic reservoirs are discussed at length. The computation results are tabulated in Tables 3 and 4. For comparison, the same K_2 and H parameter values are used ($K_2 = 0.6$ darcies, $H = 4$ meters); K_1 and H_1 can be used to accommodate various computation schemes. Computation results indicate the following patterns.

1. Positive Rhythmic Two-Layer Stratified Model:

(1) Water-Free Recovery Rate

From Figure 4, it can be seen that the water-free recovery rate decreases with the increase of \bar{K} and decrease of \bar{h} . The worst situation arises when the permeability grade difference of the two layers is great, and the high permeability layer is thin. This is verified by field data. The greater the permeability grade difference, the lower the water-free recovery rate becomes, which, in fact, is quite easy to understand. Under identical permeability grade difference conditions, the water-free recovery rate is relatively low when the thickness is fairly small; this is attributed to the fact that the thinner the permeability layer is, the smaller the reserve is; but water-free recovery comes mainly from high permeability thin layers.

Table 3. Influence of Positive Rhythmic Reservoir Heterogeneity Coefficients A and B on the Index of Recovery

(1) 参数		(2) 非均质系数		无束缚采收率	后期采收率	(7) 最终期	
h	N	A	B	(3) %	(4) %	采收率 (5) %	注入倍数 (6)
1	1	1.0	1.0	18.75	55.309	55.485	2.614
(8) 双层分带模型	1/2	2		15.00	53.351	54.248	2.891
		8		10.437	39.709	47.447	6.119
	1/3	2	1.78	12.00	54.297	54.840	2.723
		8	4.28	8.373	45.85	52.139	4.044
	1/5	2	1.89	12.375	54.788	54.968	2.600
		8	5.53	5.25	51.009	52.779	3.128
4 m	K = 0.25 darcies	1.78	2.60	11.43	47.986	51.45	3.647
4 m	K = 0.25 darcies	5.53	3.80	5.25	43.316	49.374	4.345

Key:

- | | |
|-------------------------------|----------------------------------|
| (1) parameter | (5) recovery rate |
| (2) heterogeneity coefficient | (6) number of injections |
| (3) water-free recovery rate | (7) final period |
| (4) late period recovery rate | (8) dual-layer stratified models |

Table 4. Influence of Two-Layer Model's Thickness Ratio and Permeability Ratio on Recovery Index

h	K	无束缚采收率 (1)	最终采收率 (2)	最终注入倍数 (3)	注水效率系数 (4)
1	1	18.75	55.49	2.61	21.2
1/3	2	24.75	58.68	2.18	26.0
	8	28.88	57.24	1.86	36.7
1/5	2	20.25	55.87	2.33	23.9
	8	12.75	54.15	1.80	30.1
1/10	2	19.50	55.67	2.43	23.9
	8	9.00	54.14	2.09	28.4

Key:

- | | |
|------------------------------|---------------------------------------|
| (1) water-free recovery rate | (3) ultimate number of injections |
| (2) ultimate recovery rate | (4) waterflood efficiency coefficient |

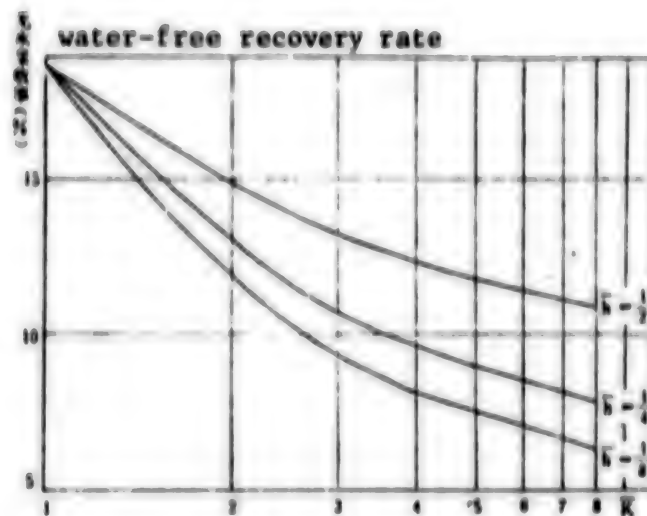


Figure 4. Curves Showing Relationship Between Water-Free Recovery Rate and Permeability Ratio, Thickness Ratio in Positive Rhythmic Dual-Layer Model

(2) The Relationship Between Water-Free Recovery Rate and Heterogeneity Factor A

To combine the effects of permeability grade difference and thickness ratio, the heterogeneity factor is introduced:

$$A = \frac{K_b}{K_a}$$

K_b -- highest permeability at bottom of positive rhythmic reservoir

K_a -- thickness weighted mean permeability

A clearcut pattern is found as the result of using A to compute the statistics of water-free recovery rate; the water-free recovery rate decreases as A increases (Figure 5). When the computation result of the positive rhythmic model described in the preceding section and the result of positive rhythmic simulation in which the bottom of the model is composed of thin layers of very high permeability, i.e. $H_1 = 0.25$ meters, $K_1 = 9.6$ darcies, are collated with the preceding curve, the outcome also tallies very well with the pattern. Thus, to a certain extent, this curve is of universal application significance, and can serve as reference in practical use.

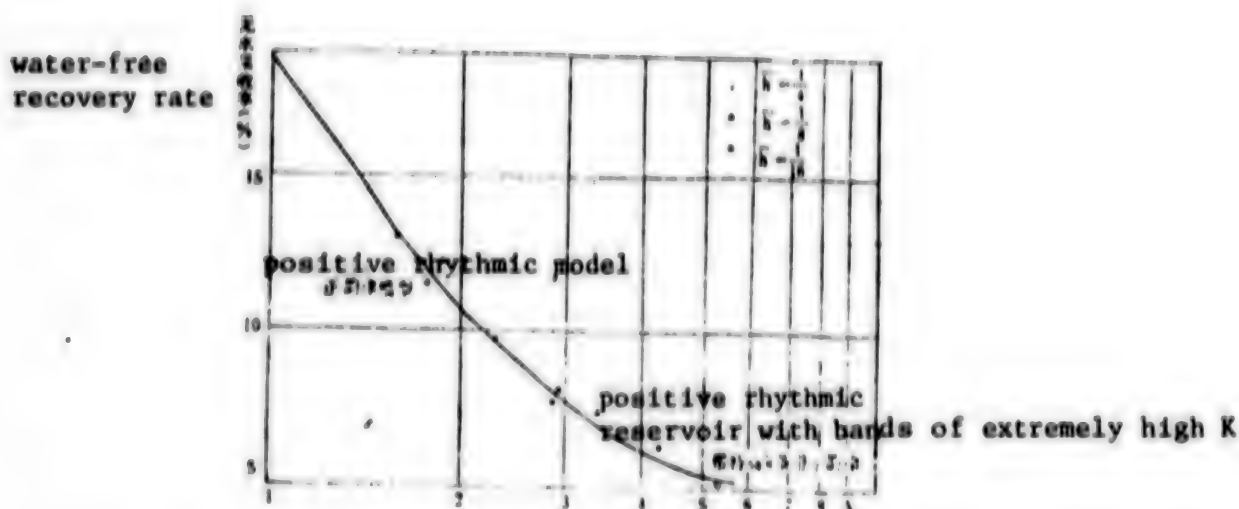


Figure 5. Relationship Between Water-Free Recovery Rate and Heterogeneity Factor A in Positive Rhythmic Reservoir

(3) Recovery Rate in the Late Stage

Late stage recovery rate is defined as the recovery rate when 2.5 volumes of water is injected. Figure 6 shows that when \bar{h} is relatively small, the late period recovery rate decreases as \bar{h} and \bar{K} increase. This is due to the fact that as the thickness and permeability of a high permeability interval increase, more and more water is consumed, which affects water scrubbing in the upper strata. But when the thickness of the high permeability interval reaches a certain value, the two-layer model becomes a model mainly composed of high permeability strata. Under such circumstances, the late period recovery rate is improved. Under identical \bar{K} value conditions, there is a point of minimum value, which, according to calculation, is located approximately between $\bar{h} = 1/4$ and $\bar{h} = 1/2$.

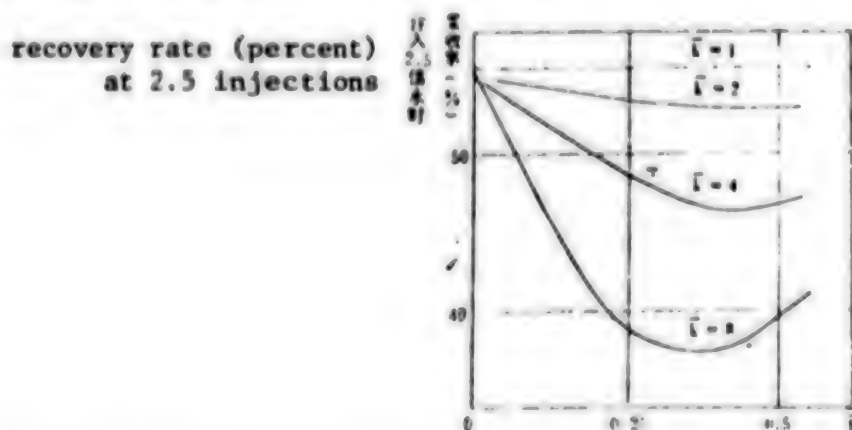


Figure 6. Relationship Between Late Period Recovery Rate and Permeability Ratio, Thickness Ratio in Positive Rhythmic Two-Layer Reservoir Model

(4) Relationship Between Late Period Recovery Rate and Heterogeneity Factor B

When \bar{h} is within a range that is smaller than the minimum value point (approximately $\bar{h} < 1/3$), the heterogeneity factor $B = \frac{K_{a1}}{K_{a2}}$ is used to produce an overall reflection of the influence of permeability grade difference and thickness ratio on late period recovery rate. K_{a1} and K_{a2} are the respective thickness weighted mean permeabilities of the lower and upper oil layers. Well-defined patterns also result from using B to compute the statistics of late period recovery rate which decreases as B increases (Figure 7).

recovery rate (percent) at 2.5 injections

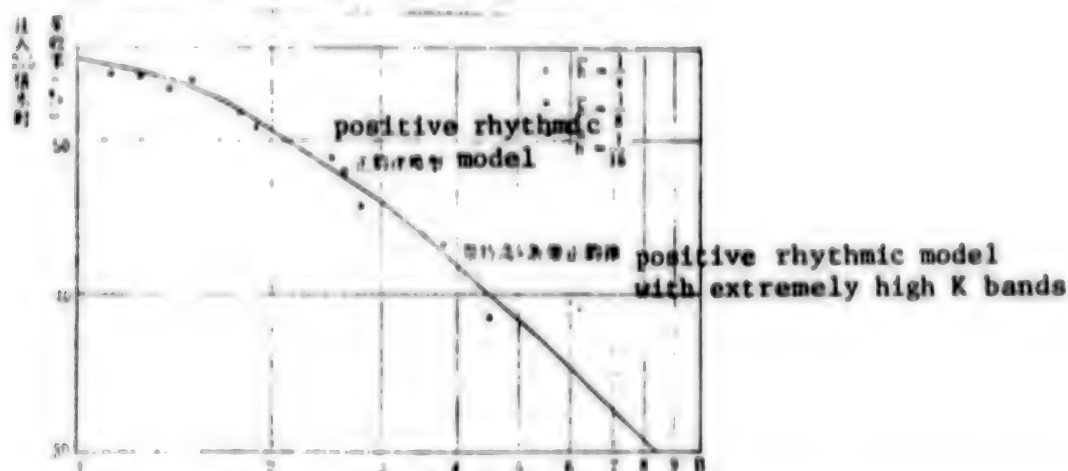


Figure 7. Relationship Between Late Period Recovery Rate and Heterogeneity Factor B in Positive Rhythmic Reservoir

2. Negative Rhythmic Two-Layer Stratified Models

(1) Water-Free Recovery Rate: From Figure 8, it can be seen that when the permeability grade difference \bar{K} is relatively small, the water-free recovery rate increases as \bar{K} and \bar{h} increase. This is due to the fact that the effect of high permeability intervals in a positive rhythmic reservoir helps to increase the sweep thickness coefficient; moreover, as the permeability and thickness increase, the effect also increases. But when the permeability grade difference exceeds a certain range, it will cause breakthroughs to occur in the upper high permeability layer first. At this point, increases in grade difference will cause the water-free recovery rate to drop. Thus, the water-free recovery rate has a maximum value point ranging from $\bar{K} = 5$ to $\bar{K} = 7$.

(2) Ultimate Recovery Rate: As shown in Table 4, there is not so much variation in the ultimate recovery rate; but the ultimate number of injections drops remarkably as \bar{K} and \bar{h} increase. The waterflooding efficiency coefficient undergoes remarkable increases. This shows that as the permeability and thickness of a high permeability interval increase, the utilization efficiency of waterflooding also increases. Thus, in a negative rhythmic reservoir, large \bar{K} and \bar{h} values are conducive to late period recovery index.

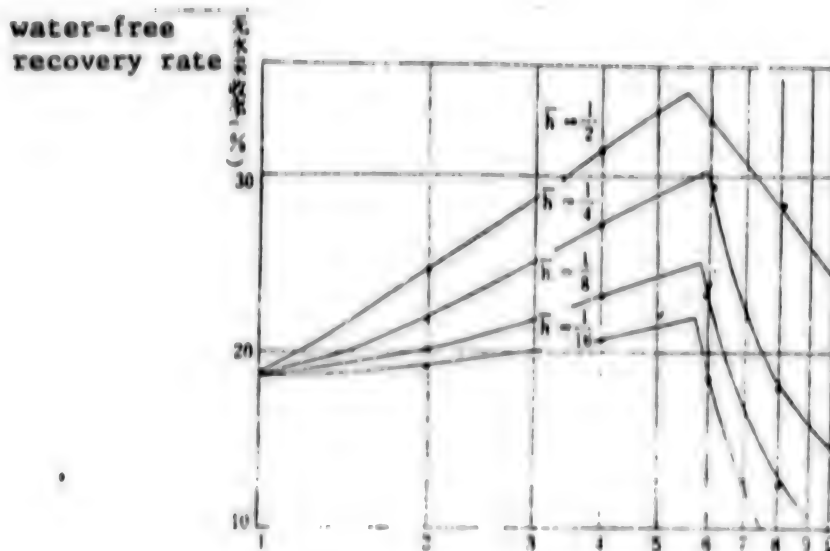


Figure 8. Relationship Between Water-Free Recovery Rate and Permeability Ratio, Thickness Ratio in Negative Rhythmic Two-Layer Model

C. Effects of the Ratio Between Gravity and Capillary Force π_2

When the oil and water densities are constant, the magnitude of gravitational force can be judged from the reservoir thickness. The gravitational force produces two effects: First, it causes the water to sink and thus reduces the sweep thickness coefficient. Second, it enhances the drive-oil efficiency of the flooded portions of the reservoir. According to small-scale indoor core water drive tests, even if the core is very small and the lithologic character is relatively uniform, the ultimate drive-oil efficiency is only 50-55 percent, which coincides with the computation results of a uniform single-tube model (disregarding gravitational force). But in the case of relatively thick positive rhythmic reservoirs, due to the effect of oil-water gravity segregation, the drive efficiency at the bottom can reach over 70 percent, which enables the ultimate recovery rate of heterogeneous positive rhythmic reservoirs to reach the same index level of uniform and small cores even if its sweep thickness coefficient is relatively small. This shows that the gravitational force in actual layers plays a conducive role in enhancing the drive-oil efficiency.

In a given oilfield, the magnitude of capillary force is reflected mainly by permeability as it is inversely proportional to the square root of permeability. The effect of capillary force is opposite to that of gravitational force, i.e., it inhibits the oil-water gravity segregation effect, and causes the sweep thickness coefficient to increase, thus reducing the drive-oil efficiency.

To study the effects of π_2 , the authors have used different permeability and thickness parameters in the computation of uniform, positive rhythmic and negative rhythmic reservoirs, and collated the results with π_2 (Figure 9).

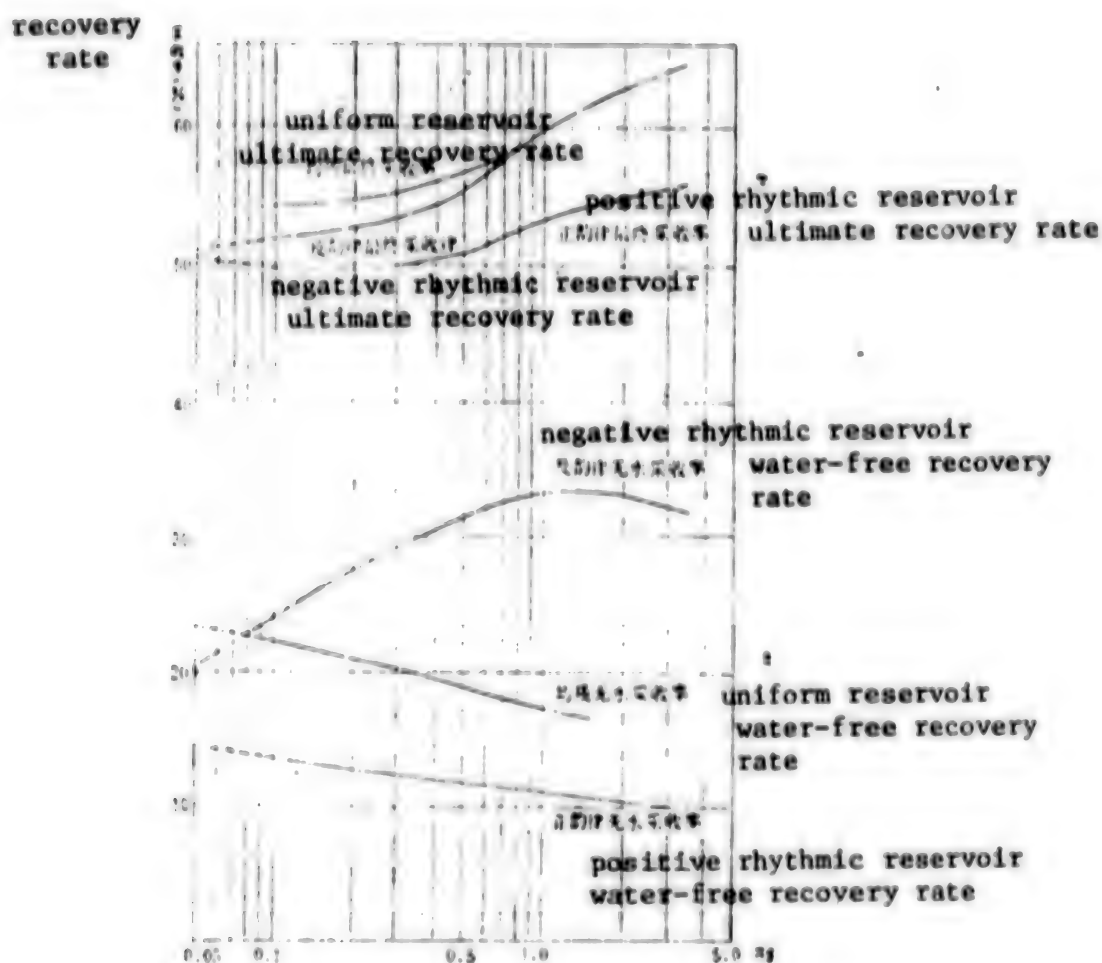


Figure 9. Influence of Similarity Criterion Number π_2 , i.e., 'Ratio Between Gravitational and Capillary Forces,' on Recovery Rate

It can be seen from Figure 9 that as far as uniform and positive rhythmic reservoirs are concerned, the water-free recovery rate decreases as π_2 increases. In negative rhythmic reservoirs, the recovery rate increases as π_2 increases. In all three kinds of models, the ultimate recovery rate increases as π_2 increases. This is because when π_2 increases, it can signify either an increase in the effect of gravitational force or a decrease in the effect of capillary force, which greatly reduces the sweep thickness coefficients of uniform and positive rhythmic reservoirs. Thus, their water-free recovery rate decreases as π_2 increases. But in the case of negative rhythmic reservoir, as the sweep thickness coefficient is relatively large to begin with, although the increase in π_2 can cause the sweep thickness coefficient to decrease, the magnitude of coefficient decrease is smaller than the increase of drive-oil efficiency. Thus, the water-free recovery rate in negative rhythmic reservoirs increases as π_2 increases. In the late stage of recovery, through an enormous amount of washing, all the models can attain fairly large sweep thickness coefficients; thus, the ultimate recovery rate is primarily dependent on drive-oil efficiency, and increasing π_2 helps to enhance drive-oil efficiency. Therefore, the overall tendency of the ultimate recovery rate of all three kinds of models is to increase with the increase of π_2 .

From Figure 9 it can also be seen that the negative rhythmic reservoir has a higher water-free recovery rate than either the uniform reservoir or the positive rhythmic reservoir, especially when π_2 is great. This is because when π_2 is great, the sweep thickness coefficient of the negative rhythmic reservoir is still relatively large, and the drive-oil efficiency is also high; but in uniform and positive rhythmic reservoirs, as π_2 increases, the sweep thickness coefficient decreases drastically, thus widening the gap between them. When π_2 is relatively small, the ultimate recovery rate of the uniform reservoir is better than the negative rhythmic reservoir. This is because when π_2 is small, the gravitational force has less influence while the capillary force has great influence, thus affecting the drive-oil efficiency in the low permeability portion of the negative rhythmic reservoir, which causes the ultimate recovery rate of the negative reservoir to be lower than the uniform reservoir. As π_2 increases, the ultimate recovery rates of both kinds of reservoirs become nearer to each other. When π_2 is great, the recovery rate of the positive rhythmic reservoir is much lower than either the uniform or negative rhythmic reservoir. This is due to the fact that it is still impossible to attain a very large ultimate sweep thickness coefficient in the positive rhythmic reservoir.

It should be pointed out that the exploitation results of large and thick positive rhythmic oil layers are considered to be relatively poor in our country at present. The authors believe that in the initial stage of development, the gravitational force is actually detrimental to the high permeability positive rhythmic thick layers as it accelerates water channeling. But the gravitational force can cause oil-water gravity segregation in microscopic bores, and thus enhance drive-oil efficiency. Calculations indicate that under the specific simulation conditions described in this article, it is possible to achieve fairly high ultimate recovery rate in the high permeability positive rhythmic thick layers. In the final stage of exploitation, the exploitation results are not any poorer than positive rhythmic thin layers of identical heterogeneous character. As a matter of fact, it can even be slightly better.

In the case of uniform or positive rhythmic low permeability thin layers, the computation results of our simulation study are quite contrary to traditional views. Although the ultimate recovery rate of this type of oil layer is higher than thick layers of high permeability, due to the increased capillary force, decreased gravitational force and reduced drive-oil efficiency in the late recovery period, its ultimate recovery rate is not high at all. But both the water-free recovery rate and ultimate recovery rate of the low permeability positive rhythmic thin layer are lower than the high permeability thick layer.

D. The Influence of Oil-Water Viscosity Ratio

Field data show that while some thick oil reservoirs are prone to serious water channeling, others are not affected at all and can furthermore be exploited with fairly good results. For example, the third sand layer of the upper oil bed in the second member of Shahejie formation of Shengtuo Oilfield is a high permeability positive rhythmic thick oil reservoir, the permeability of which ranges from 3 to 12 darcies. Serious water channeling has occurred in this

reservoir, and the flood water is very shallow. But the drive-oil efficiency of the water flooded portion is very high. The eighth sand layer of the lower oil bed in the second member of Shahejie formation of Shengtuo Oilfield is exactly the opposite: It is a low permeability negative rhythmic reservoir; although the reservoir is also extremely heterogeneous, no water channeling has ever occurred, the drive-oil efficiency is low, and exploitation results are excellent, which is much better than what we had expected. This shows that the recovery of thick oil is an oil-water displacement problem of greater complexity. It appears that the oil-water displacement is influenced by the combined effects of oil-water viscosity ratio and other factors (such as the rhythmic property of reservoirs, absolute permeability, etc).

Three typical models are chosen here for the discussion on the influence of oil-water viscosity ratio. The first is a high permeability (1.35 darcies on the average), positive rhythmic model; the second is a low permeability (0.17 darcies on the average) negative rhythmic model; the third is a high permeability (1.35 darcies on the average) negative rhythmic model. The other computation parameters are the same as those in the preceding section. Table 5 shows the computation results:

Table 5. Comparison of the Recovery Indices of Various Rhythmic Reservoirs With Different Oil-Water Viscosity Ratios

(1) 油 层	(2) 粘 度 比	(3) 无 水 期			(7) 注入2.5 倍水时采 出程度%	(8) 最 终 期		
		采 收 率 %	扫 油 厚 度 系数%	强 水 洗 刷 系数%		采 收 率 %	注 入 倍 数	注 水 洗 刷 系数%
高渗透	5	21.00	44.38	24.38	56.0	57.27	2.67	21.4
正韵律 (12)	45	6.27	19.38	1.88	37.3	43.20	4.10	9.8
高渗透	5	45.38	84.01	63.13		60.64	1.82	37.4
反韵律 (13)	45	19.68	51.25	10.43		53.35	2.33	22.9
低渗透	5	37.11	92.50	15.40	48.20	57.89	2.32	21.9
反韵律 (14)	45	15.75	65.0	9.0	41.31	45.87	3.02	19.2
		(4)	(5)	(6)		(9)	(10)	(11)

Key:

- | | |
|--|--|
| (1) reservoir | (8) final period |
| (2) oil-water viscosity ratio | (9) recovery rate |
| (3) water-free period | (10) number of injections |
| (4) recovery rate | (11) waterflood efficiency coefficient |
| (5) sweep thickness coefficient | (12) high permeability positive rhythmic |
| (6) strong water scrubbing coefficient | (13) high permeability negative rhythmic |
| (7) recovery at 2.5 injections | (14) low permeability negative rhythmic |

In sum, all three models indicate that the recovery index deteriorates with the increase of oil-water viscosity ratio; the water-free recovery rate drops, the ultimate number of injections go up, and the flood water efficiency coefficient decreases. But it appears that the effects of crude viscosity increase are chiefly reflected in two aspects: The decreasing sweep thickness coefficient and tapering off of drive-oil efficiency. The extent of influence in these two aspects differs as the rhythmic character and permeability of the reservoirs vary; and the extent to which other recovery features and recovery indices deteriorate also vary. Following is an analysis of typical situations:

First Category: High Permeability Positive Rhythmic Reservoir

As compared with the other two kinds of reservoirs, the recovery index of this type of reservoir is even more affected by oil-water viscosity ratio. As shown in Figure 10, the sweep thickness coefficient of thick crude with viscosity ratio of 45 is very small. The influence of viscosity ratio over the oil-water displacement in this kind of reservoir is primarily reflected in the decreased sweep thickness; although the drive-oil efficiency is also reduced, the amplitude of reduction is relatively small. This is attributed to the breakthrough at the bottom of the reservoir caused by the combined action of normal rhythmic reservoir gravitational force and driving force. As the water viscosity is much lower than oil viscosity, there is a great flow difference between the water flooded portion and upper pure oil portion, which causes the water displacement at the bottom to become increasingly faster and unstable. Thus, there is a great concave in the oil-water interface. Moreover, the sweep thickness coefficient is very small, and the water-free recovery rate drops drastically. But the effect on drive-oil efficiency is different. Owing to the high permeability and the ample gravity segregation of oil and water, relatively high drive-oil efficiency can be achieved even when the oil is thick. The influence of oil-water viscosity ratio on drive-oil efficiency is much smaller than on sweep thickness coefficient. Thus, in recovering thick oil from this type of reservoir, the chief problem lies in the sweep thickness coefficient.

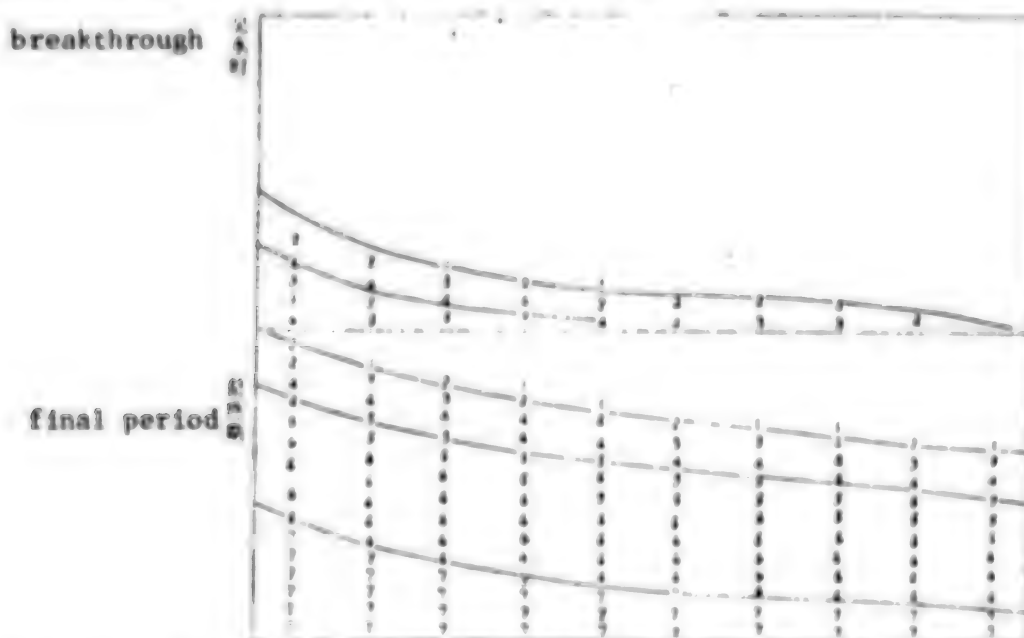


Figure 10. Waterline Chart of High Permeability Positive Rhythmic Thick Oil Reservoir

Second Category: Low Permeability Negative Rhythmic Reservoir

This type of reservoir is basically different from the preceding type. As the oil-water viscosity ratio increases, the sweep thickness factor at breakthrough reduces in small amplitudes, but the drive-oil efficiency falls in relatively large amplitudes (Figure 11). The exploitation of this type of reservoir is characterized by fairly high water-free recovery rate and relatively slow rise in water content during the initial period, which is attributed to the reservoir's low permeability and remarkable capillary action, and the fact that the high permeability interval is situated in the upper portion of the oil layer. These are the factors which cause the sweep thickness to be relatively great. On the other hand, due to the low permeability and relatively strong capillary force, it is impossible to fully segregate oil from water. Thus, other influences of oil-water viscosity ratio in this particular type of reservoir is remarkably reflected in the drive-oil efficiency. During the late recovery period, the sweep thickness coefficient can even reach 100 percent. But due to the low drive-oil efficiency, the ultimate recovery rate is only slightly higher than that of the preceding type of high permeability positive rhythmic layer, although the number of injections is reduced considerably and the waterflood efficiency coefficient is improved as well. Its overall exploitation results are better than the high permeability positive rhythmic reservoir (Table 5).

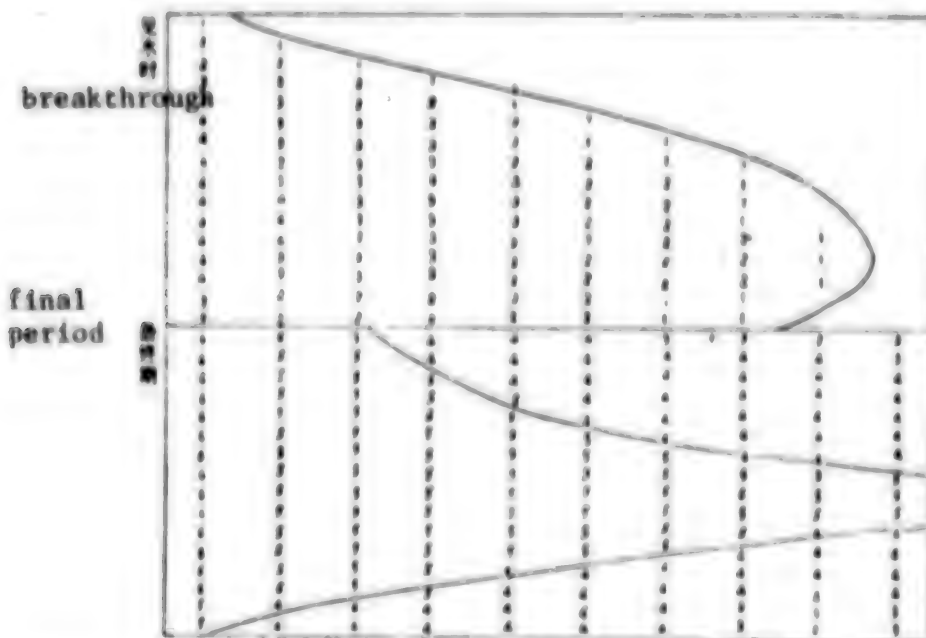


Figure 11. Waterline Chart of Low Permeability Negative Rhythmic Thick Oil Reservoir

Third Category: High Permeability Negative Rhythmic Reservoir

Based on the analyses of the preceding two types of reservoirs, it can be seen that when the reservoir's vertical distribution of permeability follows a negative rhythmic pattern, it is possible to attain fairly high drive-oil efficiency even if the oil is thick. Thus, it can be assumed that the high permeability negative rhythmic reservoir should have the strong points of the preceding two types of oil layers, and can even produce fairly good recovery results under thick oil conditions. Computation indicates that even if the oil-water viscosity ratio increases to 45, the water-free recovery rate can still reach as high as 19.88 percent, and the ultimate recovery rate is also fairly good. The sweep thickness coefficient is relatively large, the drive-oil efficiency is relatively high, the ultimate recovery rate can reach 53.35 percent, and the number of injections is increased to only 2.33 (Figure 12).

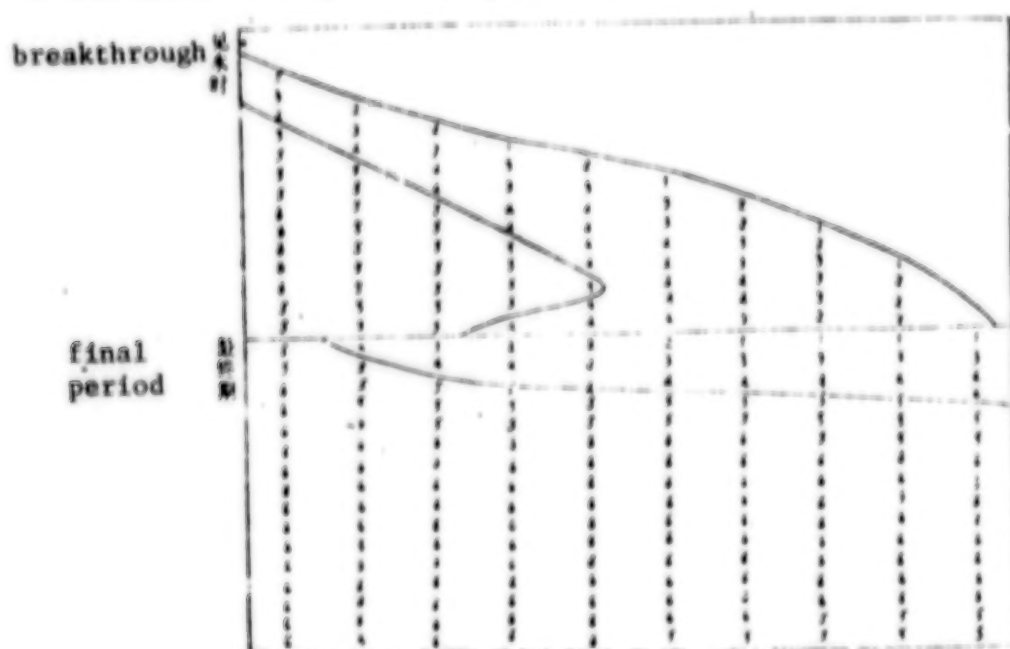


Figure 12. Waterline Chart of High Permeability Negative Rhythmic Thick Oil Reservoir

E. Other Influential Factors

We have also computed the effects of other factors (π_1 and π_4), and since the results indicate that within the oilfield's actual parametric variation range, they have comparatively small influence over the oil-water displacement, we will not dwell at length on this subject. In the positive rhythmic reservoir, for example, when the annual fluid production rate increases from 1 percent to 9 percent (correspondingly, π_1 increases from 0.006 to 0.054), the water-free recovery rate only increases from 11.34 percent to 11.73 percent, the ultimate recovery rate rises from 51.1 percent to 51.41 percent, and the number of injections decreases from 3.66 to 3.58. Basically, they do not experience much

change. Thus, in actual oil reserve conditions, to increase the drive rate merely results in shortening the time limit of exploitation as it cannot actually improve the recovery rate index at all.

IV. Brief Summary

1. The "capillary pressure curve segmented linearization" computing method is characterized by excellent stability, reliability, quick convergence and high rate of accuracy. It is a fairly good method for solving oil-water two-dimensional two-phase equations.

2. The influence of reservoir heterogeneity cannot be generalized in the assumption that the more serious the reservoir heterogeneity is, and the more acute the water channeling is, the worse the exploitation results become. It is important to specifically analyze the structural variations of reservoirs and the prominent variations in oil-water displacement features under identical permeability grade difference conditions. In a positive rhythmic reservoir, the water channeling is rapid, the water flood thickness is small, and the exploitation results are poor. But in a negative rhythmic reservoir, the waterflood thickness is great, and exploitation is excellent. The reservoir heterogeneity is not detrimental to this type of reservoir at all. On the contrary, it is beneficial. The oil-wet nature of the formation makes the difference between the two cases even more striking. The greater the permeability grade difference of the positive rhythmic reservoir is, i.e., the greater A is, the more acute the water channeling becomes, and the lower the water-free recovery rate is. But the ultimate recovery rate depends on the magnitude of B . In a negative rhythmic reservoir, within a given permeability range, the recovery index improves as the permeability grade difference and thickness ratio of the high permeability interval increase.

3. The mechanism of the effects of gravitational, capillary and driving forces. In studying the oil-water displacement in reservoirs, the gravitational force is a factor that cannot be neglected. In the case of high permeability positive rhythmic thick formation, gravity actually produces detrimental effects in the early stage of recovery as it causes the water to sink and accelerates water channeling. But the gravity is also conducive to oil water segregation in microscopic holes, and it helps to improve drive-oil efficiency. Thus, under the simulation conditions described earlier in the article, compared to positive rhythmic thin reservoirs of identical heterogeneity, fairly high ultimate recovery rate can be attained in high permeability positive rhythmic thick reservoirs.

The capillary force produces both positive and negative effects: While it is conducive to the expansion of sweep thickness during the initial period of exploitation, it also prevents the oil-water gravity segregation in microscopic holes, which is detrimental. This is precisely why high recovery rates cannot be attained in low permeability thin reservoirs during the ultimate period of recovery.

4. Influence of oil-water viscosity ratio. The increase in oil-water viscosity ratio is detrimental to oil-water displacement in two ways: First, microscopically, it lowers the displacement efficiency. Second, macroscopically, it reduces the sweep thickness. The dominance of one over the other depends on how the structure of the reservoir and other mechanical factors condition each other. In high permeability positive rhythmic reservoirs, the influence of oil-water viscosity ratio increase is mainly reflected in the reduction of sweep thickness coefficient. In low permeability negative rhythmic reservoirs, its influence is primarily reflected in the reduction of displacement efficiency. In high permeability negative reservoirs, fairly good results can be achieved in exploitation even if the oil is thick.

5. Under actual reservoir conditions, to increase the displacement rate will essentially have no effect on its recovery factor.

Owing to insufficient field data, some of the arguments presented in this article may have to be further examined in practice.

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